MECHANICAL ENGINEERING

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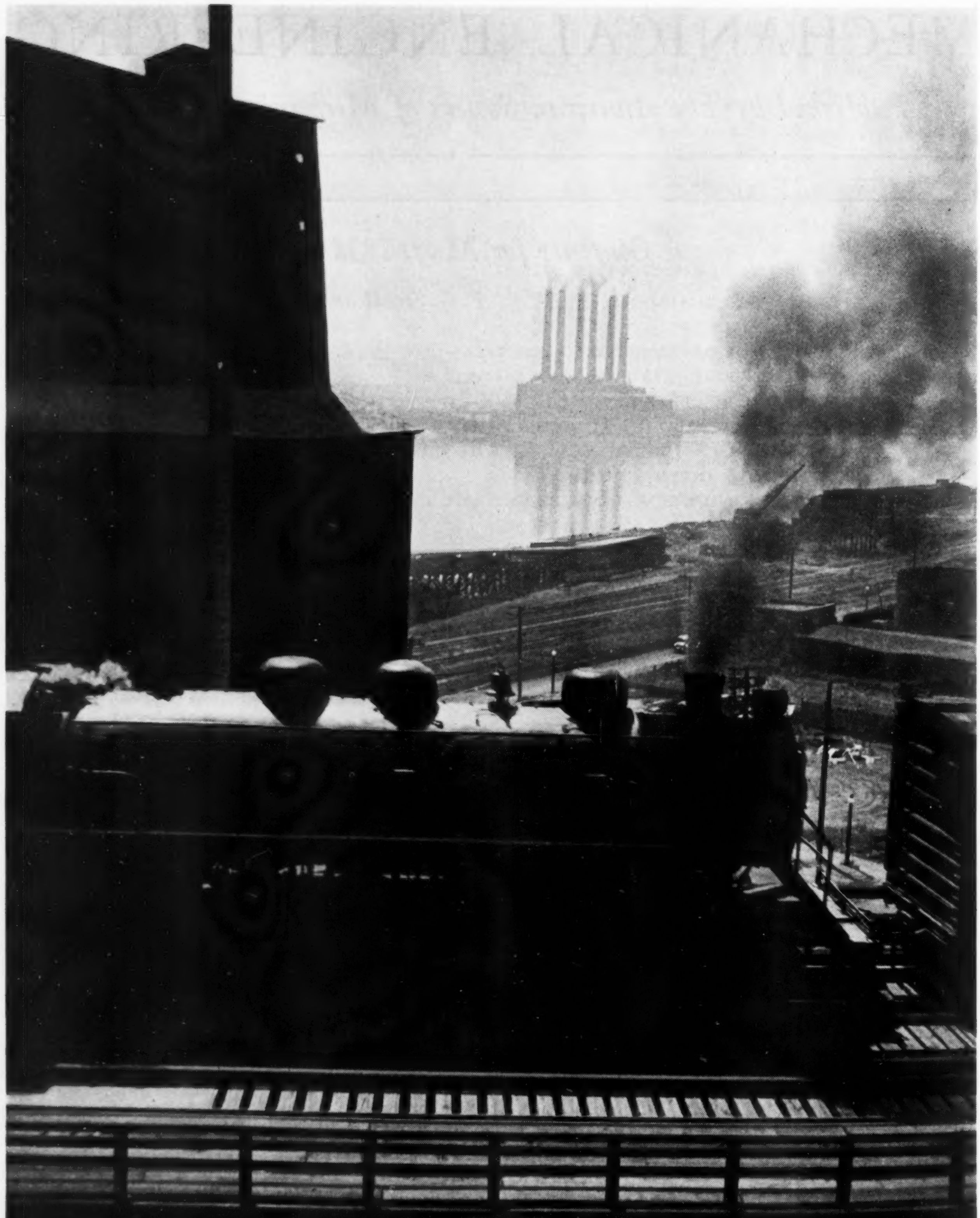

Charles Phelps Cushing

St. Louis Water Front With Cahokia Power Plant on Opposite Shore

(1938 A.S.M.E. Semi-Annual Meeting, at St. Louis, Mo., June 20–24. *See page 434)*

VOLUME 60
No. 5

MECHANICAL ENGINEERING

MAY
1938

GEORGE A. STETSON, *Editor*

Question of the Day

DURING the dark years that followed the economic collapse in 1929, MECHANICAL ENGINEERING attracted both commendation and criticism because its pages were open to articles dealing with economics subjects. With but few exceptions, the papers published had their origin in some official activity of The American Society of Mechanical Engineers. The volume of material published during this period was, in effect, an indication of the intense interest of mechanical engineers in a subject that gripped every person of intelligence and of the earnest desire of engineers to try to understand contemporary problems and be of help in their solution. MECHANICAL ENGINEERING yielded to an urge of the times.

For several months it has become evident that another problem is uppermost in the minds of many persons, particularly those engaged in the administration and management of industrial enterprises—the relationship of management to the public, and specifically to its employees. This subject is one upon which mechanical engineers may speak with more authority, perhaps, than they can command on the broader economic, social, and political phases of business cycles, or the causes and cures of depressions. For a large proportion of the best contributions to what a generation ago was known as "scientific management" came from mechanical engineers and is to be found on record in A.S.M.E. publications. Moreover, the engineer is in the thick of the industrial-relations movement because of the function he performs in industry. The subject is vital.

It is not surprising, therefore, that at Society and local-section meetings a growing number of papers are presented on subjects dealing with industrial relations. For many plants and industries, and, in a certain sense, for the country as a whole, the subject is as important as any that engineers can discuss. Hence, as readers have recently noted, MECHANICAL ENGINEERING is once more reflecting the times by giving heed to contemporary problems.

It is unfortunate that we cannot accept the "one best way" in economics and industrial-relations solutions with the same confidence with which we accept it in the findings of an authoritative analyst of a problem in applied mechanics. The engineer is at home in an environment in which truth yields to the tests of reason and conformity to physical and mathematical laws. He is likely to be suspicious and impatient when these tests cannot be so easily made. We build better turbines; but what have we learned about economics or industrial relations that can be applied with a guaranteed result? Some will reply, Nothing; let the engineer have none of it. But others, faced with the realities of a situation demanding decisions and action, will search diligently for understanding. For them MECHANICAL ENGINEERING continues to reflect the concern of engineers with questions of the day.

For Student Members

IT IS NOT the purpose of this editorial to preach a sermon but to sell a bill of goods. It is addressed to the several hundred student members who are soon to be graduated and for whom, unless they become junior members of The American Society of Mechanical Engineers, this present issue of MECHANICAL ENGINEERING will be the last they will receive. It is a plea to them to look it over with more than usual care and to decide whether or not they want to receive it in the future.

In most respects, this is a typical issue. It is unique in that it contains articles by two women members of the Society, one known throughout the world as a consulting engineer in management technique and the other a recent graduate of an engineering college just starting her career. It has a fair balance of technical and general articles typical of the wide fields in which mechanical engineers engage. Comments on contemporary events and abstracts of papers published in the magazines of the world make up the dozen or so pages devoted every month to "Briefing the Record." The A.S.M.E. News and other regular features bear witness to the numerous interests of the Society and its members. A liberal number of illustrations relieve the monotony of too many pages of solid type. And flanking the whole are advertisements that are quite as interesting to the person trying to keep up with what is going on in engineering as technical papers and news.

But MECHANICAL ENGINEERING is only one of many reasons why a young man about to enter some phase of engineering practice should take the simple and inexpensive step of transferring his student membership to the junior grade. In addition to its monthly issues, twelve sections of the Society's Transactions will alternate in arrival through the mail. With approximately the same number of text pages throughout the year, Transactions supplements the technical literature sent to all members. In the Transactions, less well known to stu-

dent members than MECHANICAL ENGINEERING, are the contributions of the Society's 17 professional divisions, its research and power test code committees, and the Society Records, comprising committee personnel, memorial notices to deceased members, and indexes to all A.S.M.E. publications, an annual permanent record of Society activities.

Valuable as publications are to a young man, personal contacts with other men engaged in engineering practice mean more to some. Meetings of the Society are scheduled with the intent of making possible participation by almost every member at some time during the year. Four national Society meetings are held annually—one in New York, early in December, one somewhere in the industrial Middle West, usually in early summer, one on the Pacific Coast, and a fourth alternating between the South and New England. Many of the professional divisions hold annual meetings at centers well distributed over the country. In seventy-odd local-sections programs devoted to technical subjects are in progress throughout the year, providing also for professional and social contacts and plant visits. In about thirty of these sections groups of juniors have their own programs directed toward professional development. Every junior automatically becomes a member of some local section, and may, without cost, ally himself with any one of the professional divisions, thus strengthening contacts with whatever branch of engineering interests him most.

A third great group of Society activity is represented by the work of technical committees, whose function it is to develop codes for construction and testing, industrial standards, and special research projects. Several hundred such committees are active, and while the work is carried on by men of experience and maturity, the results of the work constitute a rapidly growing contribution of the Society to the profession, available for all. The sound accomplishments of these committees have built up the international reputation that the Society enjoys, some reflection of which adds luster to the professional standing of every member.

Nor does the Society live to itself alone. Jointly with other societies it supports the American Engineering Council, the "Washington Embassy" of the engineering profession; the Engineers' Council for Professional Development, concerned with the selection and guidance of engineering students, the accrediting of engineering schools, the development of young engineers, and the economic status of the engineer of maturity; the United Engineering Trustees, Inc., who administer the Engineering Societies Building, in New York, the Engineering Societies Library, largest of its kind in the world, the Engineering Societies Employment Service, with offices in New York, Chicago, and San Francisco, and the Engineering Foundation, fosterer of research.

It is a lot to get for ten dollars a year, a lifelong contact started and an introduction to a professional career with possibilities as numerous and as valuable as one cares to make them. The easiest way is to get started at once. See the honorary chairman of your student branch and find out how easy it really is.

A Long Struggle

CONTROL of the smoke nuisance is a never-ended task. So much has been written and spoken about it from all points of view that, were it merely a technical problem, it would have been solved years ago. However, it is one of those public problems, like safety or traffic control, in which many interests are involved. Although the objectives are clear and commonly acknowledged as being desirable, the means of attaining them are not. Furthermore, even when civic consciousness is aroused to the point where marked progress toward effective control is made, relaxation of interest and vigilance and a breakdown of cooperation secured at the expense of prodigious effort result in the undoing of much good work. The task is continuous.

St. Louis is an excellent example of a city where smoke abatement has long been a subject of enlightened public interest. The present commissioner of the Division of Smoke Regulation of St. Louis, R. R. Tucker, presents, in this month's issue, a résumé of the history of smoke abatement in that city. It is the story of a long struggle by no means ended. It reports a further phase of the struggle, an attempt to control the character of solid fuel by an ordinance which states that "no person shall produce, import, or haul any solid fuel, nor shall any person store any solid fuel for immediate or future use in the City of St. Louis, without first obtaining a solid-fuel permit....." The obvious purpose of the ordinance is to keep objectionably smoky fuels out of the city, and thus remove one cause of atmospheric pollution.

But, as Mr. Tucker admits, the passing of the ordinance is not the ultimate solution of the problem. Domestic users must be provided with a low-volatile fuel, and the wholehearted cooperation of the public is needed. Here we are face to face with stubborn facts about smoke abatement—it costs money and must have popular support. When people want smoke abatement badly enough to insist upon it and pay the cost, they will probably get it.

Clarence Robinson

OLDER members of The American Society of Mechanical Engineers will note with regret the death, on April 12, 1938, in Bermuda, of Clarence W. Robinson, for more than forty years an employee of the Society. He began his services as a house boy at the former A.S.M.E. headquarters in 31st Street, New York City, and at the time he was pensioned in 1932 he was in charge of the stockroom. Of humble origin, he was a man who commanded and received respect. His rarest gift, perhaps, was the ability to absorb only the best from contacts with other men and to diffuse this broadly in his daily life. From such men as John Brashear, Worcester Reed Warner, and Ambrose Swasey he acquired a lifelong interest in astronomy that gave him intellectual satisfactions and spiritual insight with which to penetrate the darkness of life's viscissitudes.

BOILER-WATER TREATMENT

New Methods for Preventing Embrittlement[1]

By F. G. STRAUB and T. A. BRADBURY

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EMBRITTLEMENT occurs in steam boilers in the riveted areas, at tube ends, and other areas where stress concentrations might occur along with capillary spaces. Failures have predominated in the riveted areas although cracking has occurred in the tube ends and the tube ligaments of the drum. Manufacture of the forged and welded drums has eliminated the riveted areas and potential danger of embrittlement in these areas; however, the possibility of cracks occurring in the tube ends and the metal adjacent to the rolled tube ends still remains.

To determine whether a boiler water would produce embrittlement, the procedure has been to analyze a sample of the boiler water. Based on the results of the analyses, conclusions have been drawn and recommendations made. However, all of the conclusions and recommendations have, in turn, been based on certain assumptions. Several of these are (*a*) the boiler water concentrates in the capillary spaces adjacent to the rivets, straps, and tube ends; (*b*) a concentrated solution of the caustic soda from the boiler water causes embrittlement of the highly stressed steel; and (*c*) sulphate, carbonate, phosphate, certain oxidizing materials, and several organic materials, under limiting conditions, prevent the caustic action. Limiting conditions of some assumptions have been determined in laboratory tests; however, their direct application to operating boilers has been made with reservations. Attempts have been made to concentrate boiler waters and test stressed steel in contact with the resulting solutions. Such tests have shown that it becomes necessary to concentrate the caustic soda from around 100 ppm or less until the concentration reaches 100,000 ppm, over one thousand times. During this concentration, salts may crystallize out or the concentration taking place in the test container may bring about entirely different results than when the boiler water concentrates in the capillary areas of the boiler.

Consequently, it has been almost impossible to make definite recommendations relative to water treatment to prevent embrittlement other than to say that the water should conform to the A.S.M.E. Boiler Code recommendations which were based upon boiler operations of years ago when few boilers operated above 300 lb steam pressure. Today, with a major trend toward higher operating pressures, these older recommendations are almost meaningless.

Research has been carried on by the authors in attempting to bridge the gap between laboratory research and actual boiler operation, and it is hoped that the method of testing, which has been developed and on which patents have been applied for, will place in the hands of the boiler operators a tool with which they can control the water treatment to prevent embrittlement.

[1] Results reported are part of the investigation conducted under a cooperative agreement between the Utilities Research Commission, Inc., Chicago, Ill., and the Engineering Experiment Station, University of Illinois, Urbana, Ill., and are released by permission of both parties.

Contributed by the Power Division for presentation at the Semi-Annual Meeting, St. Louis, Mo., June 20–24, 1938, of The American Society of Mechanical Engineers.

Fig. 1 shows a section of the testing unit. The test specimen is normally made of 1-in. round hot-rolled S.A.E. 1020 steel with the center bored out, but for special tests can be made of any desired steel. Inserted into the specimen is a small steel plunger or partial filler whose diameter at the top is several thousandths of an inch less than the inside diameter of the specimen and is still further reduced below this top portion. The specimen is partially filled with the boiler water to be tested, the filler inserted and the specimen, with a thin solid iron gasket on top, is screwed into the holder at the top as shown in Fig. 2. Iron and constantan thermocouples are peened into the side of the test specimen. Another holder, fitting into a sleeve around the specimen, is screwed on the bottom of the specimen which is thus held so that, when the spring is compressed by screwing down on the top nut, a definite load is applied to the reduced section of the specimen. A small electric furnace, in which the test unit is placed, enables the specimen to be heated to any desired temperature. Fig. 3 shows two batteries of 48 test units with heating furnaces and temperature-control equipment.

TESTING PROCEDURE

In testing a sample of boiler water, 7 cc is put in a new specimen, a new oxidized filler inserted, and the unit assembled. The filler is oxidized prior to use so as to retard action of the boiler water on the unstressed filler and thus concentrate the attack on the stressed walls of the test specimen. Without the filler, no cracking will occur due to lack of capillary space where the boiler water might concentrate.

The assembled unit, without any stress applied to the specimen, is then put in the heating furnace and heated to the desired temperature for about four or five hours. At the end of this time, the spring is compressed, by using the equipment shown in Fig. 4, until the desired stress is applied. In standard tests, this is 40,000 lb per sq in. on the area at the reduced section of the specimen, although some tests have been run at higher stresses. The temperature is held at the desired value.

If the water is embrittling in nature, the specimen will break as illustrated in Fig. 5. Fig. 6 shows the typical intercrystalline embrittlement type of cracks found in the specimen after a failure caused by a sample of boiler water. The time in which a break occurs depends upon the type of water being tested. However, the fracture usually takes place within 24 hr. If no failure occurs, the test is continued for about 30 days, after which the specimen is removed, sectioned, and examined for any cracks. A water not causing failure or cracks in 30 days is classed as a nonembrittling type. Since in each test a new test specimen and filler are used, cracking or lack of cracking can be directly attributed to the water being tested. If a water is tested and found to cause failure, additional tests can be made after various chemicals have been added to the water to see what types of treatment would prevent failure.

The stress, which is applied to the test specimen, was derived as the result of a series of tests in which a dilute synthetic

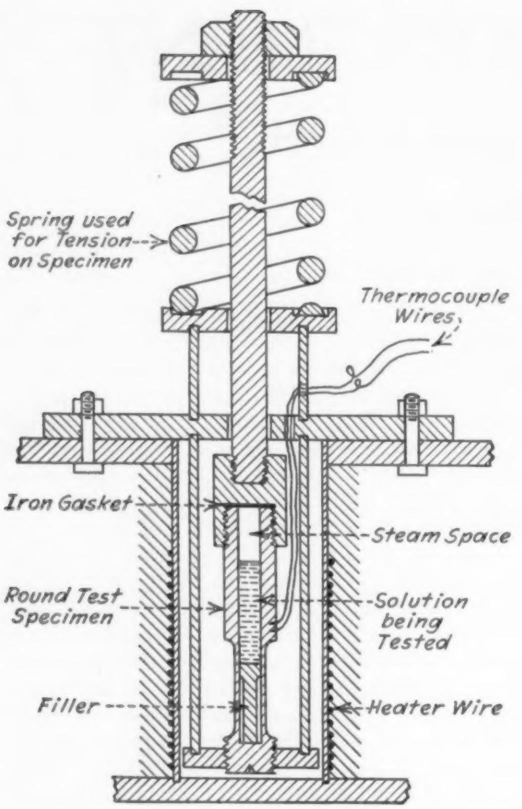


FIG. 1 SECTION OF EMBRITTLEMENT-TESTING UNIT

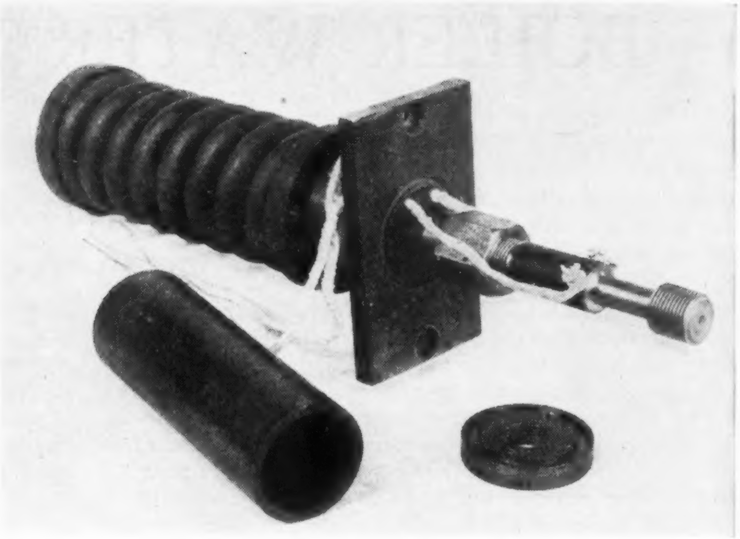


FIG. 2 SPECIMEN SCREWED INTO TOP HOLDER

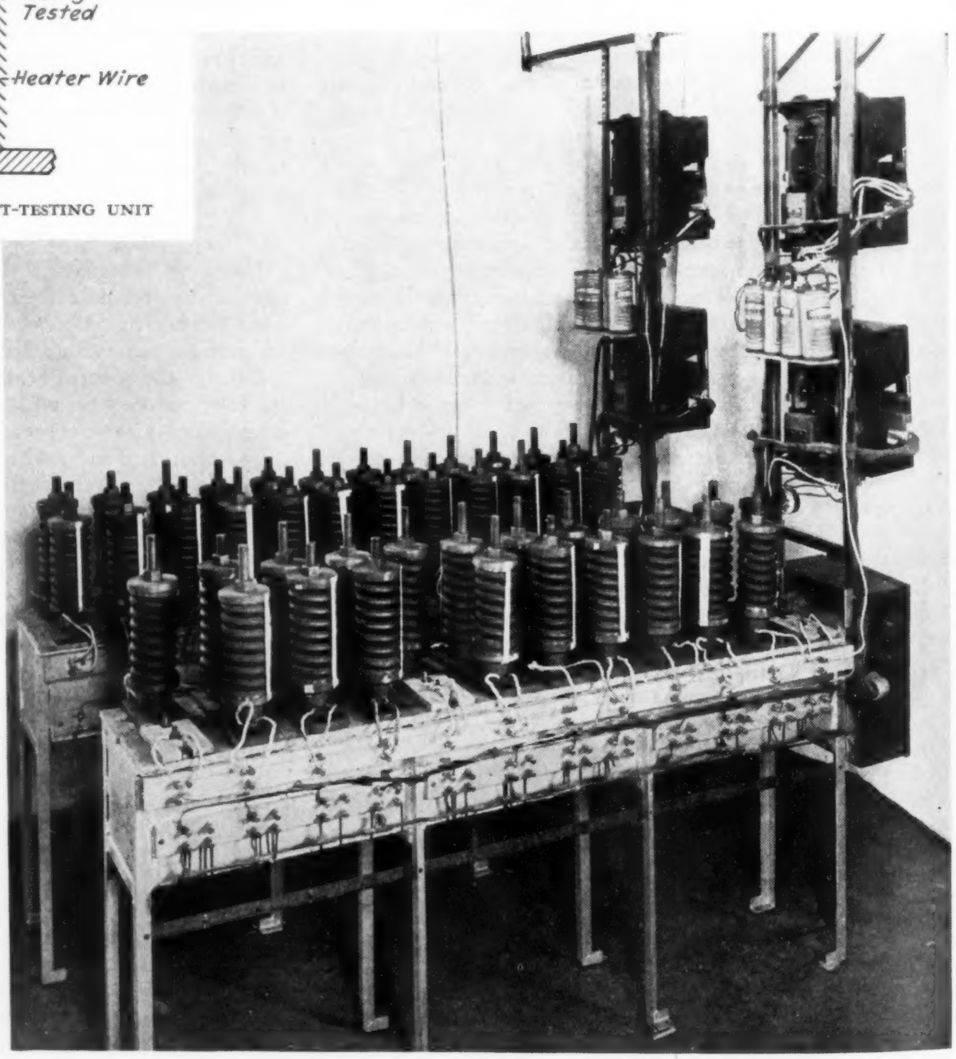


FIG. 3 TEST UNITS, HEATING FURNACES, AND TEMPERATURE CONTROLLERS

solution of sodium hydroxide and silicate was used and various stresses applied to the test specimen at different temperatures. As a result of these tests, it was found that failure resulted at temperatures between 300 and 600 F with an applied stress of 30,000 lb per sq in. At 25,000 lb per sq in., failure did not result. It appears logical that, in certain areas of the boiler, stresses above the yield point of the steel might be applied. Consequently, a stress of 40,000 lb per sq in. would be well above the point where embrittlement starts and still in the range of possible operating stresses. If no failure results with this high stress, then the water may be reasoned to be one having little, if any, embrittling tendency. If failure results and subsequent treatment prevents further failure, that treatment can be considered amply safe for boiler operation. The specimen and sample of boiler water are preheated to the desired temperature before adjusting the spring compression because stressing the speci-

men at room temperature tends to retard the embrittling action. Thus, the condition which is most favorable to embrittlement is produced by applying the stress at the elevated temperature.

Every water sample which is tested is analyzed. Thus, analyses of hundreds of boiler waters will give a definite picture of what chemicals are causing or preventing failure. Tests have been run in these test units for a period of more than 18 months, during which boiler waters from over 150 steam boilers throughout the United States have been tested. These boilers have operated at steam pressures ranging from 150 to 1400 lb per sq in. and the tests have been run at corresponding pressures. Several plants, from which these waters were obtained, have already modified their boiler-water treatment to conform to the results of these tests for preventing embrittlement and are having these modified boiler waters tested to see if they are consistently nonembrittling in nature.

Little attempt will be made at this time to explain the theory involved in this reproduction of embrittlement by boiler waters except to state that, apparently, the boiler water concentrates in the capillary space around the filler, in contact with the stressed specimen, in a manner similar to that in which it concentrates in the capillary spaces around rivets and tube ends. No steam is removed from the testing unit, and, at the end of a test when failure has not resulted, analyses of the solution remaining above the filler show a reduction in concentration. This shows that concentration has taken place in the capillary space around the filler. Boiler waters with alkalinities as low as 150 ppm have produced failure in these units.

RESULTS OF TESTS

When the results of these tests on boiler waters were first assembled, it appeared difficult to correlate them with our existing ideas regarding boiler-water treatment to prevent embrittlement. However, as additional waters were tested, it became apparent that the results were consistent.

To report results so that a direct comparison can be made with present recommendations for preventing embrittlement, they will be considered in the following three groups:

(1) Steam pressures up to 250 lb (400 F)
(2) Steam pressure 500 to 1400 lb (470 to 570 F)
(3) Steam pressure of 350 lb (425 F)

Steam Pressures Up to 250 Lb. Tests were conducted in this pressure range at 360 and 400 F. The temperature control is such that the temperature might be ±15 F. Table 1 gives the results of tests using boiler waters at 360 F, which show that embrittlement resulted even when the sodium sulphate was present in quantities that were 3.13 times the total

TABLE 1 ANALYSES OF WATERS AND RESULTS OF TESTS CONDUCTED AT 360 F (150 LB PRESSURE)

(Results in ppm)

Test no.	Water no.	Total alk	NaCl / Alk	Na_2SO_4 / Alk	SiO_2	Load applied, lb per sq in.	Time: Break	Time: No break
1759	1066	1410	0.06	0.51	72	45,000	0 to 11 hr	....
1760	1066[a]	1410	0.40	0.51	72	45,000	29 days	....
1763	1068	600	0.09	3.13	14	45,000	4 to 15 hr	....
1766	1068	600	0.09	3.13	14	40,000	9 days	....
1767	1068[a]	600	0.27	3.13	14	45,000	....	26 days
1828	1088	10150	0.40	0.90	395	45,000	....	29 days
1852	1088[b]	1015	0.40	0.90	39	40,000	....	22 days

[a] NaCl added.
[b] Diluted with distilled water.

TABLE 2 ANALYSES OF WATERS AND RESULTS OF TESTS CONDUCTED AT 400 F (250 LB PRESSURE)

(Results in ppm. No PO_4 present)

Test no.	Water no.	Total alk	NaCl / Alk	Na_2SO_4 / Alk	SiO_2	Load applied, lb per sq in.	Time: Break	Time: No break
1976	1142	304	1.13	3.8	35	40,000	....	30 days
1706	1054	1430	1.10	9.0	124	45,000	....	54 days
1771	1069	1055	0.94	3.0	152	45,000	....	40 days
1812	1084	595	0.67	2.9	128	45,000	....	43 days
1669	1041	1432	0.74	0.9	230	45,000	....	70 days
1700	Synthetic	1400	0.75	0.9	230	45,000	....	54 days
1703	Synthetic	1400	0.75	0.0	230	45,000	1 hr	....
1715	Synthetic	1400	0.00	0.9	230	45,000	1 hr	....
1705	1053	1370	0.09	1.0	100	40,000	1 hr	....
1764	1053[a]	1370	0.45	1.0	100	45,000	....	26 days
1620	21630	1400	0.10	1.1	110	40,000	5 days	....
1735	21630[a]	1400	0.60	1.1	110	45,000	....	46 days
1756	1065	905	0.44	2.9	84	45,000	....	41 days
1954	1130	502	0.96	2.9	8	40,000	....	34 days
1861	1093	304	0.34	1.2	25	40,000	5 days	....
1862	1094	580	0.28	1.3	51	40,000	14 to 16 hr	....
1905	1102	373	0.49	3.1	6	40,000	19 days	....
1941	1113	520	0.34	0.3	2	40,000	13 days	....
1953	Synthetic	500	0.00	0.0	2	40,000	1 day	....
1776	1071	522	0.20	0.4	0	45,000	....	28 days
1734	1061	2105	0.20	3.8	416	40,000	0 to 16 hr	....
1748	1063	800	0.13	4.2	124	45,000	14 days	....

[a] NaCl added.

TABLE 3 ANALYSES OF WATERS CONTAINING PHOSPHATE AND RESULTS OF TESTS CONDUCTED AT 400 F (250 LB PRESSURE)

(Results in ppm)

Test no.	Water no.	Total alk	NaCl / Alk	Na_2SO_4 / Alk	SiO_2	PO_4	Load applied, lb per sq in.	Time: Break	Time: No break
1846	1076	550	2.06	3.7	23	90	40,000	....	31 days
1857	1074	240	0.80	1.2	7	67	40,000	....	38 days
1847	1078	460	0.26	3.0	14	130	40,000	....	13 days
1834	1086	605	0.10	0.4	16	140	40,000	4 days	....
1900	1086[a]	605	0.30	0.4	16	140	40,000	....	29 days
1671	1033	1080	0.75	0.4	50	125	45,000	....	67 days
1646	1045	2450	0.18	0.0	110	160	40,000	....	29 days
1650	1046	2510	0.18	0.1	145	200	40,000	....	25 days
1655	21630[b]	1400	0.10	1.1	110	200	40,000	3 days	....
1680	1043[b]	1400	0.10	1.8	306	200	40,000	25 days	....
1639	1043	1400	0.10	1.8	306	0	40,000	8 days	....
1659	1050	1180	0.06	1.4	180	0	40,000	0 to 12 hr	....
1690	1050[b]	1180	0.06	1.4	180	150	40,000	11 days	....

[a] NaCl added.
[b] PO_4 added.

TABLE 4 ANALYSES OF WATERS AND RESULTS OF TESTS CONDUCTED AT 470 F (500 LB PRESSURE)

(Results in ppm)

Test no.	Water no.	Total alk	$\frac{NaCl}{Alk}$	$\frac{Na_2SO_4}{Alk}$	SiO_2	R_2O_3	PO_4	Load applied, lb per sq in.	Time: Break	Time: No break
1799	1083	675	0.86	3.8	110	490	0	45,000	....	33 days
1867	Synthetic	675	0.80	3.8	100	0	0	40,000	6 to 15 hr	....
1974	Synthetic	675	0.80	3.8	100	200	0	40,000	....	30 days
1781	1065	905	0.44	2.9	84	60	0	40,000	....	40 days
1787	1074	240	0.04	0.1	7	4	67	45,000	0 to 10 hr	....
1939	1074[a]	240	0.04	0.1	7	54	67	45,000	....	47 days
1791	1076	550	2.06	3.7	23	0	90	40,000	4 days	....
1836	1076[b]	550	2.06	7.4	23	0	90	40,000	8 to 16 hr	....
1894	1076[a]	550	2.06	3.7	23	7	90	45,000	....	31 days
1831	1079	850	0.14	3.2	13	5	200	45,000	....	25 days
1784	1077	410	2.10	3.6	12	0	80	45,000	36 hr	....
1837	1078	460	0.26	3.0	14	0	130	40,000	8 to 16 hr	....
1830	1078[c]	460	1.00	3.0	14	0	130	45,000	0 to 6 hr	....
1786	1079	850	0.14	3.2	13	5	200	45,000	6 days	....
1831	1079[c]	850	0.50	3.2	13	5	200	45,000	....	25 days
1946	1124	737	0.22	3.0	40	20	100	40,000	0 to 16 hr	....
1949	1124[a]	737	0.22	3.0	40	45	100	40,000	....	41 days
1994	1130	502	0.96	2.9	8	8	0	40,000	....	30 days

[a] R_2O_3 added as Al_2O_3.
[b] Na_2SO_4 added.
[c] NaCl added.

TABLE 5 ANALYSES OF WATERS AND RESULTS OF TESTS CONDUCTED AT 570 F (1400 LB PRESSURE)

(Results in ppm)

Test no.	Water no.	Total alk	$\frac{NaCl}{Alk}$	$\frac{Na_2SO_4}{Alk}$	SiO_2	R_2O_3	PO_4	Load applied, lb per sq in.	Time: Break	Time: No break
1815	1083[a]	675	0.86	3.80	110	490	0	45,000	....	14 days
1993	Synthetic	520	0.00	0.00	2	0	0	40,000	0 to 5 hr	....
1972	Synthetic[b]	520	0.34	0.25	2	3	0	40,000	....	30 days
1910	1113	520	0.34	0.25	2	3	0	40,000	....	28 days
1918	1107	276	0.29	2.19	1	2	0	40,000	....	30 days
1919	1108	228	0.32	1.01	2	4	0	40,000	....	32 days
1942	1109	350	0.49	1.48	2	3	0	40,000	....	32 days
1921	1112	224	0.31	5.55	4	6	0	40,000	....	35 days
1911	1114	515	0.47	0.20	12	15	0	40,000	....	28 days
1922	1115	172	0.44	0.94	5	4	0	40,000	....	35 days
1982	1153	340	0.25	2.77	15	8	125	40,000	2 hr	....
1983	1154	607	0.23	1.86	5	4	167	40,000	....	30 days
1984	1155	373	0.25	2.46	3	2	51	40,000	....	30 days
1996	1162	415	0.08	0.38	16	9	40	40,000	....	30 days
1964	1139	181	0.29	0.01	18	6	54	40,000	....	30 days
1997	1139[c]	310	0.17	0.01	18	6	54	40,000	1 hr	....
2016	1139[d]	310	0.17	0.01	18	6+50	54	40,000	....	30 days
1999	1163	520	0.31	1.56	35	20	60	40,000	....	30 days

[a] Run at 600 F.
[b] R_2O_3 added as Al_2O_3.
[c] NaOH added.
[d] NaOH + Al_2O_3 added.

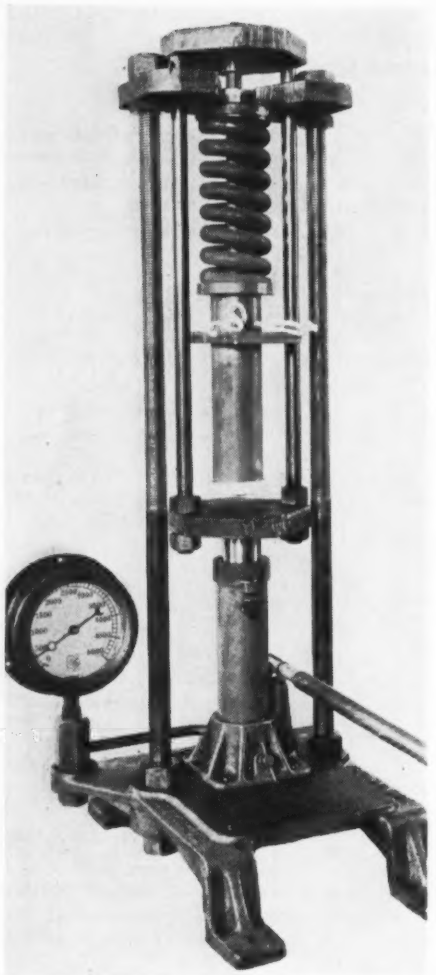


FIG. 4 HYDRAULIC PRESS USED FOR COMPRESSING SPRING

alkalinity or an A.S.M.E. ratio of 3.13.

When boiler water No. 1066 was tested, failure resulted. However, by adding a sufficient quantity of sodium chloride so that the total sodium chloride became 0.40 of the total alkalinity, the time for cracking to take place was changed from less than 11 hr to 29 days, even though the A.S.M.E. ratio was only 0.51.

When boiler water No. 1068, which had an A.S.M.E. ratio of 3.13, was tested failure resulted. By increasing the ratio of the sodium chloride to the total alkalinity from 0.09 to 0.27, embrittlement was prevented. With boiler water No. 1088, failure did not result. This water had a chloride-alkalinity ratio of 0.40 and an A.S.M.E. ratio of 0.90.

These results, while not complete, would indicate that the sodium sulphate alone does not prevent cracking but requires additional quantities of other salts such as, in these instances, sodium chloride. When the chloride-alkalinity ratio was 0.40 and the A.S.M.E. ratio was 0.90, embrittlement was prevented. When the A.S.M.E. ratio was 3.13, failure was not prevented until the chloride-alkalinity ratio was increased from 0.09 to 0.27.

Table 2 gives the results of typical tests run at 400 F in which no phosphate was present in the waters tested. Here, again, it is evident that sodium sulphate alone is not effective in preventing embrittlement. In test No. 1748, an A.S.M.E. ratio of 4.2 did not stop failure. Tests Nos. 1700, 1703, and 1715 on synthetic solutions showed that neither the sodium chloride nor sodium sulphate alone prevented failure; however, when the chloride and sulphate were combined, cracking was stopped. Fig. 7 shows a graph in which the ratio of the NaCl to the total alkalinity is plotted against the A.S.M.E. ratio to show which types of water produce failure and which do not. In considering these ratios, it should be realized that they do not take account of the actual sodium hydroxide present or the possibility of other salts, such as carbonates, nitrates, organic, and the like, which might be present. However, it is evident, as shown in Fig. 7, that sodium chloride has a marked influence on the sulphate action in preventing embrittlement. No

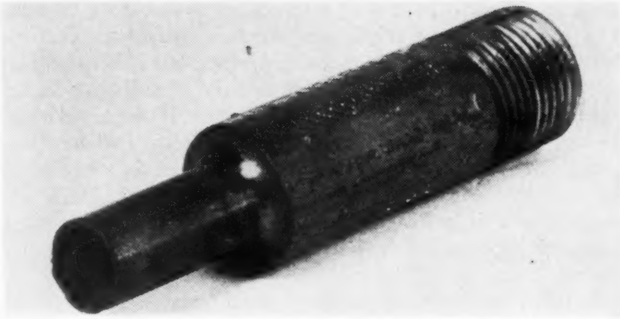


FIG. 5 EMBRITTLED SPECIMEN

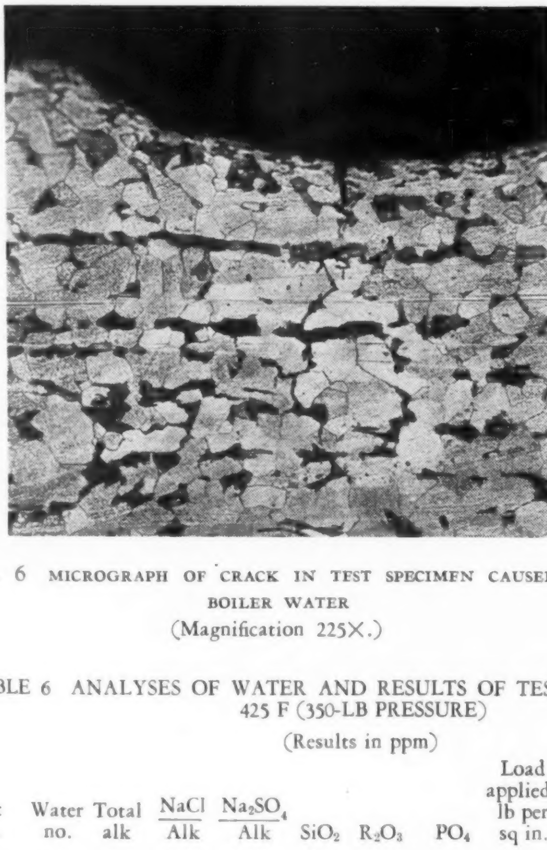


FIG. 6 MICROGRAPH OF CRACK IN TEST SPECIMEN CAUSED BY BOILER WATER
(Magnification 225×.)

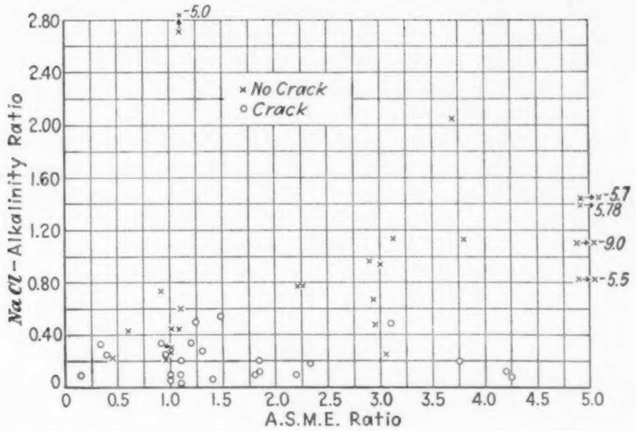


FIG. 7 INFLUENCE OF SODIUM CHLORIDE AND SODIUM SULPHATE ON CRACKING AT 400 F

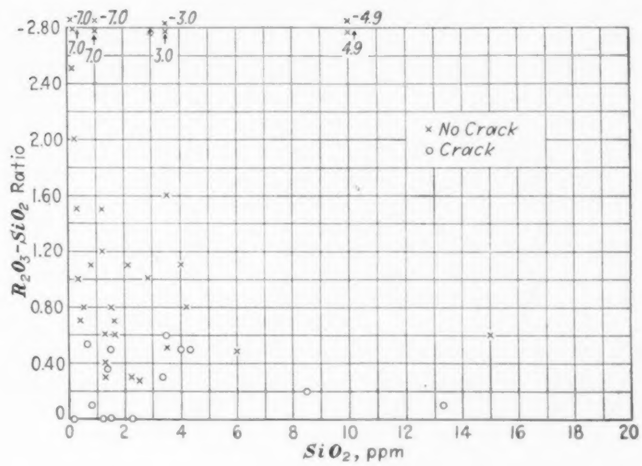


FIG. 8 INFLUENCE OF R_2O_3 AND SiO_2 ON CRACKING AT 470 AND 570 F

TABLE 6 ANALYSES OF WATER AND RESULTS OF TESTS CONDUCTED AT 425 F (350-LB PRESSURE)

(Results in ppm)

Test no.	Water no.	Total alk	NaCl / Alk	Na_2SO_4 / Alk	SiO_2	R_2O_3	PO_4	Load applied, lb per sq in.	Time: Break	Time: No break
1904	1100	735	0.37	1.3	25	15	0	40,000	....	60 days
1906	1101	384	0.36	1.2	15	17	0	40,000	....	60 days
1960	1137	250	0.42	7.16	17	7	0	40,000	....	40 days
1989	1160	373	0.19	5.10	14	6	0	40,000	....	30 days
1917	1105	330	0.18	3.9	68	18	0	40,000	4 to 16 hr	....
1928	1105[a]	330	0.18	4.4	68	18	0	40,000	10 days	....
1950	1105[b]	330	0.80	3.9	68	18	0	40,000	....	37 days
1913	1106	281	0.18	4.0	30	12	0	40,000	3 days	....
1930	1106[c]	281	0.18	4.7	30	12	0	40,000	5 days	....
1855	1076	550	2.06	3.7	23	0	90	40,000	....	34 days
1885	1064	530	0.18	0.1	52	5	15	40,000	2 days	....
1851	1064[a]	530	0.80	1.5	52	5	15	40,000	....	36 days
1869	1064[b]	530	0.35	0.1	52	5	15	40,000	....	30 days
1874	1023	395	0.38	0.7	60	28	85	40,000	....	29 days
1849	1078	460	0.26	3.0	14	0	130	40,000	....	36 days
1872	1087	477	0.54	2.0	16	14	6	40,000	19 days	....
1854	1074	240	0.75	1.2	7	4	67	40,000	2 days	....
1863	1092	340	0.35	2.2	15	7	200	40,000	2 days	....
1886	1092[b]	340	0.70	2.2	15	7	200	40,000	4 days	....
1902	1098	533	0.44	1.5	18	6	89	40,000	0 to 11 hr	....

[a] NaCl and Na_2SO_4 added.
[b] NaCl added.
Na_2SO_4 added.

failures are recorded where the chloride-alkalinity ratio is greater than 0.6 even when the A.S.M.E. ratio is as low as 0.9. However, failures have resulted with the A.S.M.E. ratios as high as 4.3 when the chloride-alkalinity ratios were below 0.6. These results would indicate the chloride-alkalinity ratio should be held at a minimum value of 0.6 with an A.S.M.E. ratio of at least 1.0 for pressures up to 250 lb.

Effect of Phosphate at 250 Lb Pressure. Compiling the results of the tests run on boiler waters having soluble phosphate present, Table 3 shows that the phosphate has some action in preventing embrittlement. In tests Nos. 1846, 1857, and 1671, the chloride and sulphate appear to be present in sufficient quantities to prevent failure even in the absence of the phosphate. In test No. 1900, the chloride-alkalinity ratio was increased from 0.10 to 0.30 with a low A.S.M.E. ratio and embrittlement was stopped. Boiler waters Nos. 1045 and 1046 appeared to have been made nonembrittling by the phosphate present. In cases where the chloride-al-

kalinity ratio falls below 0.20, the phosphate does not appear to be effective. Further tests are necessary before definite conclusions can be drawn regarding the phosphate action.

Tests at 500 to 1400 Lb Pressure. Results of tests conducted at 470 F (500 lb pressure) are summarized in Table 4. These show that the chloride-sulphate combination, which proved to be so effective at the lower pressures, does not appear to have this inhibiting action at the higher temperature. Thus, in test No. 1836 with a chloride-alkalinity ratio of 2.06 and an A.S.M.E. ratio of 7.4, embrittlement took place.

After assembling the analyses of the boiler waters and the test results, it was noted that the inhibition of embrittlement appeared to be directly related to the ratio of the R_2O_3 or the total iron and aluminum present as oxides, to the silica. Many of the waters that did not cause embrittlement had the major portion of the R_2O_3 content in the form of Al_2O_3. This led to the conclusion that the presence of a definite quantity of aluminate might react with the silica and form a complex sodium-aluminum silicate. Since silica has been considered to be somewhat of a catalyst which activates the sodium hydroxide in causing embrittlement, it appears logical that any chemical or group of chemicals which would form a complex chemical or "tie up" the silica in a form in which it would no longer activate the caustic soda would aid in preventing embrittlement. In test No. 1894, the boiler water which had previously caused embrittlement, test No. 1836, was treated with a small quantity of aluminate so that the Al_2O_3 content was increased from 0 to 7 ppm, preventing embrittlement.

Fig. 8 is a graph showing the ratio of R_2O_3 to SiO_2 plotted against the total SiO_2 content for all tests run at 470 and 570 F. It is readily noted in this graph that embrittlement is absent when the ratio of R_2O_3 to the SiO_2 is greater than 0.60. A possibility exists that the R_2O_3 may not be a definite value for preventing embrittlement, since it is a mixture of Fe_2O_3 and Al_2O_3, and the action of iron might be different from that of aluminum. At present, tests are being run to determine the relative effect of these two chemicals. Aluminum has been tested first, since it is easier to maintain it in solution. In all waters tested at these temperatures, the presence of Al_2O_3 in quantities greater than 0.6 times the silica has proved effective in preventing embrittlement.

A typical group of the tests conducted at 570 F (1350-lb pressure) are reported in Table 5. Here, it is to be noted again, that the A.S.M.E. ratio does not appear to prevent embrittlement, but that the R_2O_3 content is the influencing agent. In test No. 1964, the boiler water appeared to have no free sodium hydroxide, by the addition of neutral $BaCl_2$ test and embrittlement did not result, however, the addition of 100 ppm of pure NaOH caused this water to produce failure in 1 hr. The R_2O_3–SiO_2 ratio of this water is only 0.33, and embrittlement might be expected. Consequently, the R_2O_3–SiO_2 ratio was raised by adding aluminate to the water sample after sodium hydroxide was added, test No. 2016. The failure of embrittlement to take place again emphasizes the action of the R_2O_3.

Steam Pressures of 350 Lb (425 F). Results of tests conducted at 425 F are given in Table 6. These appear to indicate that, at this temperature, the chloride-sulphate effect is still noticeable and that the R_2O_3–SiO_2 effect might also be active. This would indicate that this temperature is about the upper limit for the use of sulphate and chloride and the lower limit for the use of the R_2O_3 to prevent embrittlement.

DISCUSSION OF RESULTS

It is encouraging to find that, as the effectiveness of one group or type of inhibitors decreases, another type becomes effective. In this particular instance, it is fortunate that the inhibitor effective at the higher temperatures is one that can be used in relatively small quantities, since this aids in keeping concentrations low. Also, it should be noted that in the majority of the boiler waters obtained from the higher-pressure boilers, this inhibitor occurs as a natural balance without any special effort to introduce it. In practically all the cases where the R_2O_3 content has been increased to prevent failure, the quantity needed has been so small that practically no problem is involved in treating the boiler water so as to give the desired ratios.

At this time, it is not proposed to recommend the universal increase of the R_2O_3 at the higher pressures. This is because of a potential danger that the R_2O_3 will combine with the silica to form silica scales of the analcite type, sodium aluminum or iron silicate $Na_2O.R_2O_3.4SiO_2$. Of course, any effort to remove or reduce the silica content to a minimum will aid in maintaining a desirable R_2O_3–SiO_2 balance.

Arrangements have been made whereby the chemical-engineering department of the University of Illinois will test boiler waters for any interested parties. These tests will involve analyses of the waters and testing samples in the new embrittlement-testing units. A nominal charge will be made for this work to cover the cost of conducting the analyses and experiments. Any profit accruing as a result of these tests will be used by the department for further research on boiler-water problems of general interest to the steam-power-plant operators. From time to time, results of these tests will be published. In this manner, it will be possible to assemble these data at a central disinterested laboratory and, at the same time, answer the question whether any particular boiler water is embrittling or not for the power-plant operator. Of course, the source of the samples tested will not be revealed.

The containers which should be used to hold the water samples during shipment depend upon the type of boiler water being furnished. For water samples taken from boilers operating below 350 lb pressure, glass containers may be used. For higher pressures, the samples should be sent in metal containers, such as tin-lined cans, or paraffin-lined glass bottles.

SUMMARY OF CONCLUSIONS

A summary of the conclusions reached from the data obtained is as follows:

(1) A new method for testing samples of boiler water to determine whether or not they will cause embrittlement has been developed and is available for testing samples of boiler waters. As these tests are continued, they will, undoubtedly, result in the determination of more chemicals having a definite bearing on the cause and prevention of embrittlement.

(2) For steam pressures up to 250 lb per sq in., embrittlement can be prevented by maintaining the sodium-chloride content of the boiler water greater than 0.6 times the total alkalinity, expressed as sodium carbonate, along with the sodium-sulphate content greater than 1.0 times the total alkalinity.

(3) For steam pressures between 500 and 1400 lb per sq in., embrittlement is not prevented by the maintenance of the present recommended A.S.M.E. ratios. The presence of a soluble R_2O_3 content greater than 0.6 times the SiO_2 content of the boiler water appears to prevent embrittlement at these pressures.

(4) For a steam pressure of 350 lb, the ratios of sulphate and chloride to alkalinity as well as the R_2O_3–SiO_2 ratio both appear to be effective in preventing embrittlement, although larger quantities may be necessary than at lower or higher pressures.

SMOKE ABATEMENT

Its Past, Present, and Future in St. Louis

By R. R. TUCKER

COMMISSIONER OF SMOKE REGULATION, ST. LOUIS, MO.

IT HAS BEEN customary in the past when writing a paper on smoke abatement to review the history of this subject from time immemorial. Whether the writers have been motivated by an inferiority complex or have been tacitly admitting the futility of any program they are sponsoring, it is hard to say. This display of erudition has not only been the privilege of the layman but also of the engineer. The facts that are gleaned from this research of past performances definitely prove that the problem not only did exist but still does. In fact, in its present form, it has transcended its former status and is fast becoming a menace of such proportion that it will eventually destroy our urban centers unless it is effectively controlled and solved.

Available bibliographies on this topic are voluminous and comprehensive. It is possible to obtain statistical data upon all its phases and ramifications. The public has been informed as to the condition of their lungs, their sanity, their vitamins, their property, and their cleaning and laundry bills. Figures that have been given conclusively show that mountains of fly ash and soot and tons of sulphuric acid are showered upon our citizens annually. Solutions are proposed and generally discussed in the most verbose manner. For the past century, it has been a prolific subject for conversation among engineers, who display their technical training by enunciating the fundamental principles of combustion. Performance of fuels burning in suspension, partially in suspension, and in a quiescent state upon the grate have been thoroughly investigated. Theories have been expounded regarding the combustion of the volatile constituents of coal, oil, and gas and subsequently revised. Of what value is all this work? Does it indicate that most of the answers to all the problems that arise in the burning of fuel either are known or can be had? If this is the case, more progress certainly should have been made along this line of endeavor.

Engineers as a whole, although intensely interested, have had an apathetic attitude toward the solution of this problem. This may be dictated by their lack of desire to become embroiled in a controversy that might harm their personal standing in the community or by the natural reticence that is inherent in the average engineer. However, some engineers are associated with various plants that are not only violating present ordinances but also have violated ordinances that have existed in the past. It might be said that their influence is not sufficient to cause any radical change which might eliminate the nuisance they observe. This may be true in many cases, but tactful and persistent presentation of facts would aid materially in clearing up violations that are persistently countenanced. The engineer is held responsible, and, irrespective of the attitude he may assume, the general public looks to him for the solution. He must recommend the solution, even though the remedy is drastic in character. The public is entitled to full knowledge of the truth.

Contributed by the Fuels Division for presentation at the Semi-Annual Meeting, St. Louis, Mo., June 20–24, 1938, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

A review of the past history of smoke abatement in St. Louis will no doubt be refreshing to those who have been active in work of this nature. Strange as it may seem, St. Louis has been struggling with this problem for only 73 years. England, it is said, became conscious of the deleterious effects of smoke in the thirteenth century. This should not act as deterrent in our activities.

$50 SMOKE DAMAGES AWARDED IN 1864

St. Louis in the year 1864 became conscious of its smoke through the altercation that arose between two neighbors, the nature of the complaint being as follows:

> Plaintiff states that he has been damaged by defendant to the amount of fifty dollars, in this, that he, plaintiff, is owner and occupier of certain premises described as follows: One house and lot situated on Poplar Street, south side, between Nineteenth and Twentieth Streets; that defendant is the owner and occupier of premises adjacent to the house occupied by plaintiff; that said defendant has erected or caused to be erected on his (defendant's) premises, a certain frame shed, a portion of which encroaches on the premises of plaintiff, and that from said shed project two stove pipes, the smoke from which, through the wilfulness, negligence and carelessness of said defendant, escapes into and on the premises of plaintiff, rendering his house almost untenantable, and otherwise injurying the same, whereby plaintiff is damaged in the sum of fifty dollars, as above stated, and for which said sum he prays judgment against said defendant.

In this particular case, a judgment of $50 was rendered in favor of the plaintiff. This was later affirmed by the Supreme Court of the State. No doubt, the attendant publicity of this case resulted in the passage of the first ordinance in the City of St. Louis pertaining to the emission of dense smoke. Although not specifically mentioning smoke it did definitely state that all chimneys had to be 20 ft above the surrounding buildings. This ordinance was approved in 1867.

The records would indicate that little interest was evidenced in the question of smoke between 1870 and 1892. The first engineering report on smoke was filed in 1892. This report was written by E. D. Meier, William B. Potter, Robert E. McMath, and C. E. Jones. No doubt, some of the older members of the Society recall the members of this committee. As the report is the first printed record on smoke in St. Louis, its contents are of interest. It stated that St. Louis had suffered "more than any other important city of the country" from a combination of conditions "most unfavorable to the improvement and metropolitan development of any community." These were classified as unpaved streets and water—"unwholesome" and often repugnant in appearance—and "an atmosphere polluted with smoke." The first two, the committee declared, were no longer sources of serious concern. The streets were now well-paved, and the work was far advanced of installing the main low-service pumping plant at Chain of Rocks, "far above the sources of pollution from city and suburban drainage." But there still remained "the purification of the atmosphere by the proper abatement of the smoke nuisance," declared the committee.

As it is the practice now or as it was the practice then as it is

now, the filing of this report resulted in the passage of two ordinances in 1893, one declaring the emission of dense black or thick grey smoke to be a nuisance and provided for the suppression thereof. The nature of the other is expressed in a quotation from the first section:

Said Commission shall conduct and make practical tests of all devices for the prevention or suppression of smoke which shall be submitted to them, in accordance with the conditions hereinafter set forth, and shall prepare detailed reports, stating the facts and conclusions based thereon, as to the efficiency of such device, the conditions of its successful operation and the limitations to its efficiency. Said report shall be made promptly, when any test is completed, to the board of public improvements, which report may be rejected by said board if found to be unfair or untrue. If accepted by said board, the report shall be published for the information of the public.

Said commission shall also be called upon by the president of the board of public improvements to make such tests and experiments, as may, in his judgment, be needed to determine the applicability of special smokeless fuels to domestic, locomotive or other uses, with a view to the abatement or suppression of smoke, and shall prepare detailed reports of the results, together with such conclusions and recommendations as in their judgment may be warranted by the facts, said reports to be made promptly and printed for the information of the public.

STATE SUPREME COURT DECLARES ORDINANCE VOID IN 1897

With the passage of this ordinance, the question of smoke was apparently on a sound basis for the time being. For four years, these ordinances were enforced and then arose one of the peculiar quirks attendant to legislation; the city endeavored to enforce the law against one recalcitrant violator. Out of this dispute, arose the following decision by the State Supreme Court, which was handed down in 1897:

Our conclusion is, that while it is entirely competent for the city to pass a reasonable ordinance looking to the suppression of smoke when it becomes a nuisance to property or health or annoying to the public at large, this ordinance must be held void because it exceeds the powers of the city under its charter to declare and abate nuisances and is wholly unreasonable. The judgment of the St. Louis Court of Criminal Correction is affirmed.

The city was then without the authority to proceed against violators. The smoke unmolested continued to belch its dirt and contents upon St. Louisans.

PROGRESS MADE BETWEEN 1899 AND 1937

A new ordinance, which conformed to the decision of the Supreme Court, was passed in 1899. This was followed by the passage of a law by the State Legislature in 1901 declaring the emission of dense smoke into the atmosphere in cities of 100,000 or more to be a nuisance, which gave St. Louis the desired authority. The validity of this law was attacked in 1904, but was upheld by the State Supreme Court. For the next nine or ten years, a lull occurred in the legislative program. This was supplanted by the activities of various civic groups interested in the abatement of smoke. History shows that sincere efforts were made to enlist public support and widespread educational campaigns were launched. How effective this was can be ascertained from the furor that was raised after the Legislature amended the law passed in 1901 to read as follows:

. . . Provided, however, that in any suit or proceeding under this section, it shall be a good defense if the person charged with a violation thereof shall show to the satisfaction of the jury or court trying the facts that there is no known practicable device, appliance, means or method by application of which to his building, establishment or premises the emission or discharge of the dense smoke complained of in that proceeding could have been prevented.

After the passage of this law, the Department of Smoke Regulation was again flooded with complaints. A vigorous campaign of enforcement was started amid the plaudits of the press and the civic groups. The result of this campaign is described by the following quotation from "Smoke Abatement, a Study of the Police Power as Embodied in Laws, Ordinances and Court Decisions," by Lucius H. Cannon:

When violators neglected to observe repeated warning notices Mr. McKelvey started suits against them, whereupon, it is stated, both public and private agencies failed in their support of the Building Commissioner. These facts and the onset of the world war brought about the discontinuance of prosecutions. They also resulted in the passage of a new ordinance. . . .

DIVIDED RESPONSIBILITY HAMPERS SMOKE ABATEMENT

The new commissioner, in declaring his policy, advocated one of education rather than prosecution. The department continued to function until 1932 when it was combined with the Department of Boilers and Elevators. This resulted in a serious setback to the smoke program, as responsibility was divided and little attention was paid to such an unpleasant and unproductive subject as smoke. During this period, certain civic-minded groups organized the Citizens Smoke Abatement League. Private subscriptions financed its efforts, and a wholehearted and sincere attempt was made to educate the public regarding this matter.

The administration changed in 1933 and, in the early part of 1934, a committee was formed to study the subject. The recommendations made at that time were similar in character to those embodied in the present ordinance. The recommendations failed to receive public support. In the last six or seven years little or nothing has been done on smoke abatement. In the last four years, only one man has been assigned to the performance of these duties.

As we glance over these records, we find it reeks with ordinances. The fundamental fallacy in all smoke programs is that air can be purified by legislation. No administration or public officials can wave a wand and clear the skies. The public must come to a full realization of its responsibilities. If they are given the facts and the way pointed toward the solution, then it becomes as much their problem as the administration's. So far, the citizens of St. Louis have been presented the facts. They have been informed that, under the present ordinance, industry, railroads, and the larger commercial buildings can be controlled. However, a complete solution will not be had until a smokeless fuel is produced and marketed at a fair and equitable figure.

History of smoke elimination in the last 73 years in St. Louis should conclusively prove to its citizens that legislation will not abate smoke. It also indicates that some of those who condemn the lack of progress most vociferously are the greatest offenders. Therefore, it behooves those in charge of this work to instigate steps that will produce the desired results irrespective of the opposition.

With the discouraging background just depicted, the present administration employed a well-known consultant on smoke to make a thorough investigation of the conditions in St. Louis. An ordinance was drawn up with this report as a basis. A separate department was formed, and all necessary features were incorporated, such as requirements for fees, permits, certificates, authority to seal boilers, and limitations were placed upon the use of hand-fired equipment. It incorporated a definition of dense smoke and the permissible period of violation. Furthermore, provisions were made for the control of fly ash. It was felt, however, that one fundamental was lacking, the control of fuel being shipped into St. Louis. This need was

accentuated by the fact the suggested ordinance sought to control soot and fly ash but did not include any provision curtailing the sulphurous content of our atmospheric air. Inclusion of such a feature would place the program upon a more comprehensive basis. The problem would then be attacked from the angle of air pollution rather than smoke alone. The following section, known as Section 18, was written as a portion of the ordinance. In its final form, it states:

Importation, Sale, Use or Consumption of Certain Coals Prohibited. It shall be unlawful to import, sell, offer for sale, expose for sale, exchange, deliver or transport, use or consume in the City of St. Louis, any coal in sizes which will pass through a two inch (2") circular opening or its equivalent, which contains in excess of either twelve per cent (12%) ash or two per cent (2%) sulphur on a dry basis, unless such coal, before importation or sale in the City of St. Louis, has been cleaned by a process known as washing, so that when said coal is so washed, it shall contain no more than twelve per cent (12%) ash on a dry basis. The term "washing" . . . is meant to include purifying, cleaning or removing impurities by mechanical processes of removing refuse from coal, regardless of the cleaning medium used. It shall be unlawful to import, sell, offer for sale, expose for sale, exchange, deliver or transport, use or consume, in the City of St. Louis, any coal in sizes which will pass over a two inch (2") circular opening or its equivalent, unless such coal before importation or sale in the City of St. Louis shall have been hand picked or cleaned by other modern methods, so that the visible impurities shall not exceed three-fourths of one per cent ($^3/_4$'s of 1%) per ton. Visible impurities shall be deemed not only to include all free foreign matter, but shall also include bands one-fourth inch ($^1/_4$") or more in thickness adhering to the outside of pieces of coal, and any band or bands of foreign matter one-fourth inch ($^1/_4$") or more in thickness visible to the eye on two faces of a piece of coal, or any band one inch (1") or more in thickness visible in one face. The foregoing provisions shall not be effective until July 1, 1937, and the Commissioner of Smoke Regulation may extend the time after said date, subject to the approval of the Appeal Board.

ORDINANCE PROVOKES CONTROVERSY BUT IS PASSED

Considerable controversy resulted when this particular division was proposed. However, after a meeting was held with the producers from Illinois, the operators revised and wrote Section 18 in its present form. The press, special interests, and some of the uninformed public claimed that this section was unnecessary; they contended that it would destroy our trade territory. Boycotts were even threatened by various small towns in Illinois. However, the administration, realizing that a forward step had to be taken, did not cease in its efforts to pass this ordinance. It was passed and became an ordinance on Feb. 11, 1937.

At no time, however, did we claim that Section 18 would eliminate smoke. It was claimed, however, that Section 18 would reduce sulphur and fly ash and produce a fuel of uniform quality with higher calorific value which would adapt itself more readily to underfeed stokers and produce a fuel with a higher fusing point of ash, thus improving the fuel-bed conditions and reducing clinker trouble. In addition, certain hidden returns will affect the maintenance cost. To those accustomed to using coals containing low ash and sulphur, the necessity for a provision of this character may seem preposterous. However, it is not unusual to receive from this market coals containing as high as 30 per cent of ash and 5 to 6 per cent of sulphur. Consequently, some steps were essential to curb the use and production of fuel from this source. Besides the advantages previously outlined, this section of the ordinance has established the right to control the type of fuel being used within the city limits.

Shortly after the passage of this ordinance, the Air Hygiene Foundation of America, Inc., on Sept. 1, 1937, published the results of its examination of the air in and around the City of St. Louis. These indicated that the sulphuric content of atmospheric air in St. Louis was approximately $2^1/_2$ times that of Pittsburgh, 5 times that of Philadelphia and Detroit, and 18 times that of Washington, D. C. Maximum concentration of SO_2, 1.8 ppm, was obtained in the vicinity of the railroad yards. The second highest SO_2 concentration, 1.7 ppm, was at Eighth and Olive Streets, in the heart of the business district. When one realizes that the stations chosen by the Foundation were not chosen with the idea of obtaining a maximum concentration but an average, the necessity for some movement to reduce the acid content of our air becomes apparent. Enforcement of this provision of the ordinance will be had by the control of the solid-fuel dealers.

CONTROLLING SOLID-FUEL DEALERS AIDS SMOKE ABATEMENT

On Oct. 28, 1937, a companion ordinance to the smoke ordinance was approved. It is described by quoting Section 2 of Ordinance 41173, City of St. Louis, which states that "no person, shall produce, import or haul any solid fuel nor shall any person store any solid fuel for immediate or future hauling for use in the City of St. Louis, Missouri, without first obtaining a solid fuel permit as provided in this ordinance."

A fuel dealer or importer is required to file an application with the Division of Smoke Regulation giving full and complete facts pertaining to the organization of his company, his equipment, and source of solid-fuel supply. Before any application or permit shall be approved, the applicant is required to file with the Commissioner of Smoke Regulation a bond which has been executed by some surety company. The purpose of the bond is to hold harmless any person, purchaser, or purchasers involved in any transaction with the permittee pertaining to the importing, producing, or hauling of solid fuel for consumption in the City of St. Louis. It further stipulates that any person obtaining such a permit shall not violate any of the provisions of this ordinance or any ordinances or laws regulating the handling, storing, or importing of solid fuel.

Section 10 of this ordinance specifically states that the Board of Public Service shall revoke the permit of anyone, who after the passage of this ordinance shall have been convicted of violating any ordinances of the City of St. Louis concerning the use or consumption of solid fuel, the inspection and regulation of handling solid fuel, or misrepresenting the size, grade, quality, weight, or method of preparation of solid fuel.

It may be seen, therefore, that, under the provisions of this ordinance, a dealer who violates Section 18 may be denied the right of doing business in the City of St. Louis. As an aid to the dealer, a list of acceptable sources of supply was compiled from published data pertaining to the type of equipment possessed by the various mines in the State of Illinois. Local mines were sent a questionnaire in an endeavor to obtain information regarding their equipment. From the available data, the mines were then classified into two groups; one was approved for all sizes of fuel and the other for sizes over 2 in. This approval as a source of fuel supply in no way guarantees that the fuel produced will meet the requirements of this ordinance but is merely an assurance that the mines possess equipment that will enable them to conform to the provisions of the ordinance. Dealers are responsible for the type and quality of fuel that they haul. It is their duty to see that the fuel that they dispense in the city of St. Louis conforms to the provisions of the ordinance. Failure to do so will result in the cancellation of their permit. So far, we have had splendid cooperation in enforcing this provision and, as time goes on, it will become more effective.

The Commissioner of Smoke Regulation assumed his duties on Oct. 16, 1937. Enforcing the ordinance enacted the earlier part

TABLE 1 ACTIVITIES OF THE ST. LOUIS SMOKE REGULATION DEPARTMENT FOR THE THREE MONTHS ENDED DEC. 31, 1937

Inspections on permits	1011
Inspections without permits	218
Inspections on permits rejected	8
Inspections—not home	259
Telephone complaints received	627
Permits issued	
Under 1000 sq ft of radiation	467
Over 1000 sq ft of radiation	109
Certificates issued	576
Inspection permits issued before office was operating	300
Applications received for solid fuel permits	1466
Railroads	
Observations	4481
Violations	84
Special reports	23
Special calls	
Firing instructions given	116
Smoke observations	159
Burning tests	18
Special investigations	8
Plant surveys	17
Coal calls	15
Coal samples picked up	12
Summonses issued	25

of this year and all subsequent ordinances became his problem. The aid of a Joint Engineering Council of St. Louis was enlisted in preparing an examination for the inspectors. They not only prepared the examination questions but also corrected the papers. As a result of this procedure, the inspectors are of high character and possess unusual ability for the type of work in which they are engaged. The work of the department, for the first three months of its existence, can be seen from an inspection of Table 1.

In 324 cases, conditions were corrected by the use of low-volatile fuel and the installation of mechanical equipment. The work of the department has been greatly enhanced by the cooperation that has existed between the WPA organization and this office. The projects that have been used in this particular work have been of infinite value in checking up on the progress that has been made.

WPA SURVEYS SMOKE CONDITIONS AND HEATING PLANTS

One project was used to conduct a comprehensive visual survey of smoke conditions in the City of St. Louis. Observation points were established upon ten tall buildings, four of these stations being located along the eastern portion of the city, three through the central portion, and three through the western portion. Four men constituted a crew and were equipped with binoculars and Ringelmann charts and forms for recording the data. Five such crews have been trained. Before any readings were taken, they were carefully instructed in estimating densities and were compelled to make observations at the foot of the stack on all questionable cases. Observation periods were of 4 hr duration with readings taken each minute. Two of the crew were placed at one corner of the building and the other two were located diametrically opposite. Thus, visibility was had in two directions by each group. One man recorded the data as the other made the observation. These crews worked $6^1/_2$ hr per day for 4 days per week. The $2^1/_2$ hr that remained after the observation period were spent in identifying new violators and assembling the data for the office records. Four days are spent at one station and they are then moved to another. Working in conjunction with these five crews are six statisticians who check and analyze the field reports. This analysis resulted in the following breakdown with regard to densities: Residential, apartments, institutions, industrial, commercial, and miscellaneous.

An accurate record is kept of all conditions that may affect the density readings such as visibility, mean temperature, relative humidity, wind direction and velocity, and barometric pressure. Information of a similar character is kept of conditions at the St. Louis Airport and an effort is being made to correlate these data. On those days when visibility is bad, the crews work their territories on foot. Violations reported by these observers were followed up by letter and in many cases by our inspectors.

This constant surveillance produced definite results, the density of smoke, which was computed according to accepted methods, showing a marked reduction in all classifications. The largest decrease, 11.65 per cent, or from 15.50 to 3.85 per cent, was in the commercial group. The smallest reduction was in the institutions. Residential density decreased 3.99 per cent. These figures are based upon the data assembled from a total of 6253 observations distributed as follows: Industrial, 1771; commercial, 2454; institutions, 562; apartments, 771; residential, 663; and miscellaneous, 30. Consequently, it may be judged from these figures that some progress has been made. However, they mean little to the average citizen, and should only be considered as a check on the activities of the department, and no conclusions should be drawn from them. These results were the natural consequences of constant observation. The Division of Smoke Regulation has impressed the operator of the plant with the fact that he is being constantly watched. As a result, more care is used in firing.

Another WPA project has been compiling a list of heating plants by types in the City of St. Louis. A representative area was chosen from a district where this work had been completed. From this area, which comprises approximately one third of the total area of the city, 17,750 cards were taken as a sample. These were analyzed to ascertain the percentages of the various heating units in this area which contained single residences, multiple dwellings, institutions, industrial, and commercial groups. The distribution was interesting and showed coal stoves, 61.8 per cent; hot-air furnaces, 24.1 per cent; hot-water heating, 8.3 per cent; steam, 4.7 per cent; and oil and gas, 0.9 per cent. This project is about 75 per cent complete, and an analysis of 104,000 cards indicates the following distribution: Coal stoves, 38.45 per cent; hot-air furnaces, 42.01 per cent; hot-water heating, 10.67 per cent; steam, 5.73 per cent; and oil and gas, 3.14 per cent.

These figures would definitely indicate that the solution of the problem in St. Louis must provide a source of smokeless fuel to this large group of domestic consumers. At present, St. Louis has passed an ordinance that is not the ultimate solution of the problem. It only affords a solution for a portion of our problems and is nothing more than a sound foundation upon which the department can build. Time and experience, no doubt, will point the way toward the ultimate solution. Nothing more has been claimed. With proper enforcement, the large type of plant can be controlled and the smoke practically eliminated. The efforts of the department are being exerted toward that end. The future will be bleak indeed unless the large mass of domestic users are provided with a low-volatile fuel. This, however, will never be if the program does not receive the unqualified support of the citizens of St. Louis. It is a physical impossibility for a commissioner with a deputy and eight inspectors to watch and control the emission of smoke from at least 140,000 different sources. No divine power is attached to the title of Commissioner of Smoke Regulation. Miracles cannot be performed by legislative acts. The department can only point the way; the final solution can only be attained through the wholehearted and continued cooperation of all concerned.

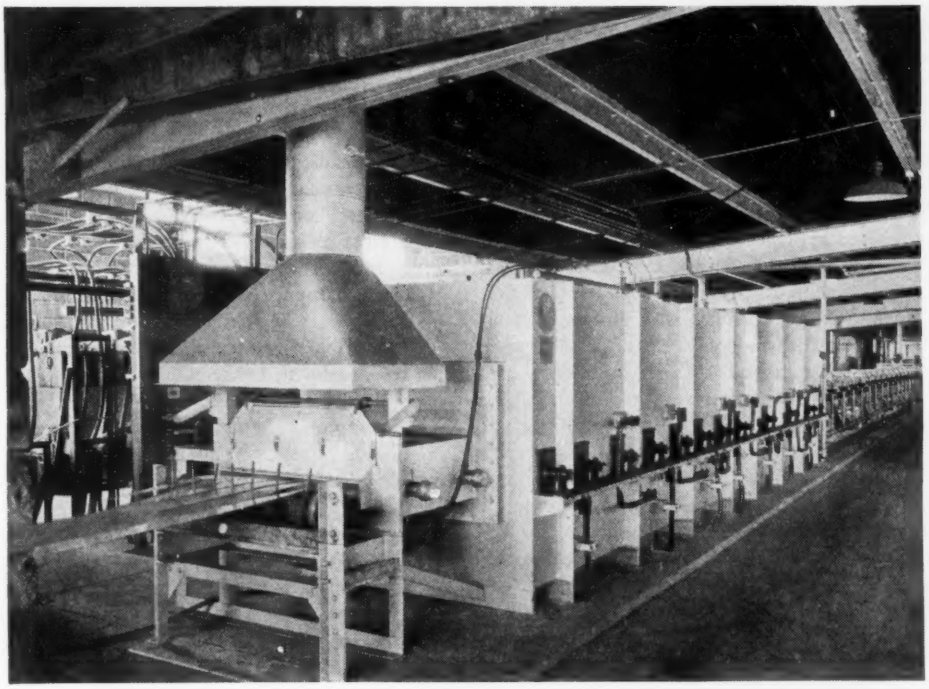


FIG. 1 TYPICAL MODERN ELECTRIC FURNACE

FUELS *for Industrial* HEATING FURNACES

By M. H. MAWHINNEY

CONSULTING ENGINEER, SALEM, OHIO

THE MOST important influence affecting the development of fuels for industrial heating furnaces has been the growth of the art of metallurgy. Tales of the early, romantic days of steel making, when races between rival melters to tap their open-hearth furnaces were won by heroic measures, illustrate the total absence at that time of the metallurgical control in effect today. Similarly, heating ingots and billets for subsequent rolling and forming was the simplest part of the process in the beginning, and most of the product was used without any elaborate heat-treatment to obtain physical properties. The absence of strength was offset by massive design. With the development of the automobile, the necessity for strength has resulted in attention being paid to physical qualities, which are almost always a measure of the quality of heating.

In the initial forming operations in steel manufacture, the temperature of rolling must be held within definite limits for best results. In final heat-treatments, exacting temperatures are essential. Table 1 gives some of the principal heat-treating operations and the reasons for them.

In each of the operations given in the table, the maximum allowable temperature variation for satisfactory results is 20 F, and the temperature range given in the table covers the varying critical temperatures of the large number of steels commonly heated. Tables on pp. 480–482 of the 1936 "Metals Handbook" of the American Society for Metals show the SAE numbers and give chemical compositions of some of these steels, illustrating the wide range of different products involved in the metallurgy of steel. Developments in nonferrous metallurgy have been similar to those of the steel industry, and the art of

TABLE 1 PRINCIPAL HEAT-TREATING OPERATIONS AND REASONS FOR THEIR USE[1]

Operation	Usual temperature range, F	Purpose and result
Quenching	1375–1650	For hardness; also produces brittleness
Tempering	250–1250	For toughness, controlled hardness, and strength
Normalizing	1550–1750	For grain refinement and uniformity after forging or rolling
Low anneal	1250–1380	For ductility and relief of forging and rolling strains
Full anneal	1450–1550	For softness, machineability, and grain refinement
Spheroidize	1280–1425	For maximum softness and ductility
Strain relief	400–1100	To remove aging and machining strains

[1] Compiled by A. P. Terrile, Pittsburgh Crucible Steel Company.

Contributed by the Fuels Division for presentation at the Semi-Annual Meeting, St. Louis, Mo., June 20–24, 1938, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

ceramics has had a like history in promoting the manufacture of ceramic products by the application of exacting heating specifications.

Control of decarburization is a specific example of changes in metallurgical specifications. All early steel was decarburized and could only be hardened by removing the surface before treatment, but today steel specifications call for some minimum depth of decarburization, and the reaction between the fuel and the steel must be controlled. Decarburization is caused by the fact that the carbon in the steel has a greater affinity for oxygen in the furnace atmosphere than it has for the iron with which it is associated. It can be prevented by a furnace atmosphere that has no oxygen in a form available for reaction with the carbon, or its effect can be offset by an atmosphere so high in oxygen that the steel is oxidized and removed in the form of scale at a rate greater than that of the decarburizing reaction. Both methods are commonly used, and the fuel plays an important part in constantly maintaining the proper atmosphere in each case. Decarburization varies with the temperature and the time of exposure in addition to the atmosphere and is measured by the depth to which all carbon has been removed, total decarburization, plus the additional depth to which part of the carbon has been removed, partial decarburization. Total decarburization of 0.040 in. is not uncommon where no attention is paid to the furnace atmosphere, but many specifications permit only 0.005 in. on rods and bars.

Another important influence upon fuel technology was the development of the electric furnace which is a clean, quiet, efficient, and accurate heating tool. Almost overnight, the fuel-fired furnace found itself at a disadvantage in every respect except operating cost, and immediately great strides were made in fuel-furnace design, along the lines of appearance, insulation, temperature and combustion control, and burner design. Furnace building became an art, and a new industry came into being for the construction of the moie complicated and scientific designs. Fig. 1 illustrates a typical electric furnace.

CONTROL METHODS AND APPARATUS AFFECT APPLICATION OF FUELS

Development of controlling methods and apparatus has greatly affected the application of fuels. These controls now cover every function in the operation of a heating furnace, including temperature, fuel-air ratio, furnace pressure, mixing of two or more gases to maintain a constant heating value, refractory temperatures in open-hearth furnaces, automatic reversal of regenerative furnaces, heating cycles, and safety devices. Of particular importance are the controls for furnace temperature, atmosphere, and pressure without which it is difficult to heat properly either metallic or refractory products requiring the application of heat in their manufacture.

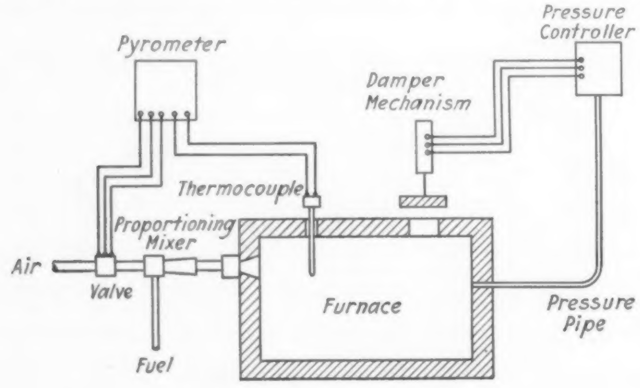


FIG. 2 FURNACE CONTROL SCHEME

Fig. 2 is a diagram showing the principles involved in a typical heating-furnace control system. Thermocouples may be of the radiation type or two-wire couples utilizing platinum for high temperatures and iron-constantan or chromel-alumel for lower temperatures up to 1800 F. Pyrometers may be either indicating or recording controllers and usually operate a motor-driven valve for either the simple alternating high-low operation or more complicated and accurate operations involving anticipating and proportioned flow features that will produce an almost perfectly straight line on the temperature chart. Pressure recorders are actuated by the pressure in the furance and operate a damper to maintain this pressure constant at all rates of fuel flow. The setting is usually 0.01 in. of water.

Modern burners for all fuels are scientific devices incorporating all kinds of development since the pipe burners used on early furnaces. Burners now efficiently fulfill their function which is to mix the fuel with a proportioned volume of air and the degree of mixing necessary to insure the complete combustion of every particle of combustible in the furnace. In accomplishing this purpose, burners have become devices involving accurate and careful machining to detailed designs.

Table 2 is an outline of the burners that are commonly used for various fuels in the firing of industrial heating furnaces.

TABLE 2 BURNERS USED WITH DIFFERENT FUELS IN INDUSTRIAL HEATING FURNACES

Fuel	Description	Approximate pressure per square inch: Fuel	Air	Remarks
Oil and tar	Steam atomizing	10 to 40[a]	1/2 to 4[c]	Steam at 60 lb per sq in. minimum
	Low pressure	10 to 40[a]	8 to 16[c]	40 to 50 per cent of induced air
Producer gas	Mixing type	2[b]	4[c] to 5[a]	Cleaning provisions
Blast-furnace gas	Proportioning	3[c]	8 to 16[c]	Automatic air-gas mixing
Natural and artificial clean gases	Blast type or nozzle mixing	4 to 8[c]	3 to 16[c]	Separate air and gas control
	Proportioning	3[c]	8 to 16[c]	Automatic mixing
	High pressure	10 to 25[a]	atmosphere	All air inspirated
	Luminous or radiant	3 to 8[c]	3 to 8[c]	Luminous flame

[a] Pounds.
[b] Inches of water.
[c] Ounces.

Following these improvements in burners and control for the higher grades of fuel, successful applications of cruder but cheaper fuels to refined heating have recently been made. These latter include blast-furnace and coke-oven gases produced as by-products of the steel mills and producer gas made from soft coal.

New fuels introduced to compete with older sources of heat are also changing the design of heating furnaces in various parts of the country. One of the major industrial changes in this country involves the miles of pipe line constructed to supply natural gas to the Eastern states from the Southwest in competition with artificial gases made from coal. Another change in the midwest and the New England states has resulted from the commercial introduction of butane, a by-product of gasoline manufacture, as an industrial fuel.

Butane is shipped and stored in liquid form under pressure. When the pressure is released and the latent heat of vaporization is supplied by steam, the liquid gasifies and is distributed

to heating furnaces in gaseous form. One gallon of liquid butane weighs 4.84 lb and will produce 31.46 cu ft of gas at 60 F and atmospheric pressure. The specific gravity of the gas is 2.01 (air = 1.0), and the heating value is 3260 Btu per cu ft. Combustion is very similar to that of natural gas.

Producers for manufacturing clean gas from anthracite coal have also been adopted by a considerable number of manufacturing plants in recent years. This is a perfectly clean gas which burns and can be controlled the same as natural or artificial gas. The producers range in size from about 40,000 to 100,000 cfh of 150 Btu gas. The approximate analysis of the anthracite producer gas is given in Table 3. The gas is usually made from No. 2 buckwheat coal, although other sizes can be used.

APPLICATION OF FUELS

The limited scope of this paper does not permit any extended discussion of details of fuel application, other than the more important of recent changes with their probable effect upon the future of fuel technology. Fuels commonly used in industrial heating furnaces are listed in Table 4, which also shows the cost per million British thermal units for each fuel for an assumed fuel price in each case. Such a comparison is, of course, based upon the assumption of equal combustion efficiency. Cost of preparing the fuel is included in each case.

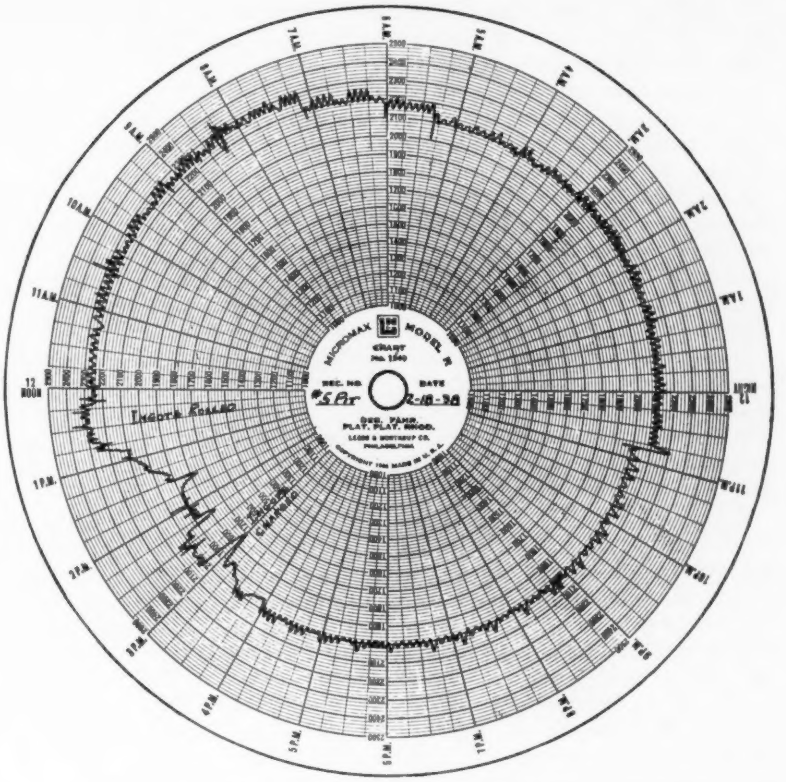


FIG. 3 TEMPERATURE RECORD FROM A CONTROLLED SOAKING PIT

With sufficiently high air preheat, blast-furnace gas has been successfully used alone at temperatures up to 2400 F, but ordinarily it is mixed with fuels of higher heating value such as coke-oven gas. Blast-furnace gas is a by-product of the manufacture of iron in the blast furnace and an average analysis is given in Table 3. The specific gravity of the gas is about 0.95 (air = 1.0), and the heating value is low because of the high percentage of inert nitrogen.

Raw producer gas is a dirty gas made from bituminous coal and contains considerable soot and tar. It is generally carried hot to the furnace in brick-lined mains at a temperature up to 1400 F, depending upon the distance between the producer and the furnace. The tar content condenses rapidly at temperatures below 900 F and solidifies at about 200 F, which greatly increases the difficulties with control valves. One pound of bituminous coal will produce between 70 and 75 cu ft of gas having a heating value of 140 Btu per cu ft, so the thermal efficiency of conversion is about 70 per cent and the heat in the gas per pound of coal converted is usually taken at 10,000 Btu per lb. The gas leaves the producer at a pressure of approximately 2 in. of water, and the mains must be large to prevent pressure drops. An average analysis of raw producer gas is given in Table 3.

Burners have been developed for burning raw producer gas in heating furnaces in a manner similar to other gaseous fuels, but the process is complicated by dirt and tar in the gas. By careful attention to the arrangement of valves for cleaning, excellent control of temperature can be accomplished with this gas, as illustrated in Fig. 3, which shows the temperature control in a producer-gas-fired regenerative soaking pit arranged by the author for automatic temperature and pressure control.

The advantages are that a uniform atmosphere is maintained in the pit and a maximum set temperature cannot be exceeded, which results in better heating from a metallurgical standpoint and, in addition, materially improves the condition of

TABLE 3 ANALYSES OF GASES USED AS FUEL IN INDUSTRIAL HEATING FURNACES

Constituents	Anthracite producer	Blast furnace	Raw producer	Protective
CH_4	0.8	...	3.0	1.1
C_2H_4	0.1	...	...	...
CO	27.1	27.8	20.5	9.8
CO_2	5.0	7.1	7.5	5.0
H_2	16.6	...	12.5	12.1
N_2	50.0	65.0	56.5	72.0
O_2	0.4	0.1	...	...
Total	100.0	100.0	100.0	100.0

TABLE 4 COST OF HEAT PER MILLION BRITISH THERMAL UNITS WITH FUELS COMMONLY USED IN INDUSTRIAL HEATING FURNACES

Fuel	Heating value	Assumed cost	Cost of heat
Anthracite producer gas	150[a]	$5.00[c]	$0.42
Raw producer gas	140[a]	2.45[c]	0.20
Blast furnace gas	90[a]	0.01[d]	0.11
Coke oven gas	500[a]	0.08[d]	0.16
Artificial gas	550[a]	0.70[d]	1.27
Natural gas	1000[a]	0.30[d]	0.30
Butane	3260[a]	0.06[d]	0.58
Fuel oil	140,000[b]	0.04[e]	0.34
Tar	150,000[b]	0.04[e]	0.32
Residue pitch	165,000[b]	0.025[e]	0.15

[a] British thermal units per cubic foot.
[b] British thermal units per gallon.
[c] Cost of coal per ton.
[d] Per 1000 cu ft.
[e] Per gallon.

the bottoms. Substitution of air blowers for steam injectors and automatic gas-pressure control have also contributed to the improvement of quality in producer gas.

A recent development of great importance in the field of industrial-furnace fuels, particularly in the application of refined gaseous fuels, is the rapid growth of clean heating and bright heating in the metallic industries. The former refers to the heating of metals without the formation of oxides, or scale, but with permissible discoloration, usually resulting from impurities on the surface of the metal when charged into the furnace. The latter permits no change in the appearance of the surface of a clean and bright metal as the result of heating. Both results are accomplished by the chemical control of the atmosphere in the furnace during heating and cooling. This atmosphere is usually made in a separate generator by the partial combustion of clean gas followed by the removal of resulting water vapor and, in some cases, by the absorption of carbon dioxide, as in cases where decarburization of high-carbon steels must be avoided.

A typical analysis of a protective gas made from natural gas burned at about 2000 F in the presence of a suitable catalyst and with 6 parts of air to 1 part of gas is given in Table 3. A typical generator for such gas comprises a brick-lined combustion chamber, a condenser for water-vapor removal, and a refrigerator for further removal of water vapor. Such generators are used for steel products, and both the furnace and cooling hood must be filled with the gas if control of the surface of the steel is to be accomplished. For the bright annealing of copper, separate generators are not required, but the furance must be kept under pressure to exclude all air, and an air-gas ratio not exceeding 90 per cent of the theoretical combustion air must be consistently maintained.

Electric furnaces were originally used for this type of heating because of difficulties with large gastight muffles in fuel-fired furnaces, but the development of radiant-tube heating has now made the fuel furnace a satisfactory application. With radiant tubes, the fuel is burned inside metal tubes that act as muffles as well as radiant heaters in the furnace. Oil has not been extensively applied to such applications because of the small quantity of heat to be liberated in each tube.

Another development in industrial heating is convection heating in furnaces up to about 1500 F temperature. In this type of furnace, the fuel is burned in a separate combustion chamber, and the products of combustion are circulated rapidly in the furnace by fans that are designed to handle hot gases. The benefits from this type of heating are pronounced at relatively low temperatures, where large savings in heating time and great improvements in temperature uniformity are obtained. Table 5 shows the percentages of heat transmitted by radiation and by convection in a furnace at various temperatures, and illustrates the reason for the advantages of circulation at temperatures below about 1500 F.

TABLE 5 HEAT TRANSMISSION BY RADIATION AND BY CONVECTION IN A FURNACE

Furnace temperature, F	Percentage of heat transmitted by Radiation	Percentage of heat transmitted by Convection
200	50	50
400	66	34
600	75	25
800	80	20
1000	83	17
1200	86	14
1400	89	11
1600	92	8
1800	93	7
2000	94	6

The effect of this method of firing upon fuel selection is almost the opposite of that of radiant tubes, because one or two burners replace a large number of smaller ones in the furnace when fired by usual methods. The change, therefore, is advantageous to fuel oil where the price of oil is lower than that of available gas. An excellent example of this type of heating is the flash baking of lime-coated wire where the baking time with rapid circulation is a matter of a few minutes as compared with several hours in the usual baking ovens. Other applications include tempering and aluminum-heating furnaces and many others.

FUTURE TRENDS IN FUEL TECHNOLOGY

In the future, the trend of fuel technology as applied to industrial heating furnaces will probably be toward the application of the cheaper fuels for heating large furnaces at temperatures above approximately 2000 F. This will be accomplished by further improvements in the application of these fuels, and, with such improvements, some of the ground lost by these fuels in the recent race for quality will be regained as the necessity for economy as well as quality increases.

For furnaces of intermediate temperature, about 1800 to 2000 F, and for small furnaces at high temperatures, fuel oil and coke-oven gas, the latter used directly as in the steel mills or mixed with other gases as supplied by the utilities, will probably compete on a straight price basis with the clean gases, such as natural gas, artificial gas, and butane.

In heat-treating furnaces at temperatures from about 1300 to 1800 F, development of nonoxidizing heating will work in favor of the clean gases capable of the finest possible control, even at some disadvantage in price.

At still lower temperatures, convection heating is most logical and should become a permanent improvement, especially as the liquid fuels and dirty gases can again be applied successfully, when available, at a saving in cost.

Use of heat-saving has made rather slow progress in this country but will be of increasing interest in the future. Control of atmospheres in regenerative, or Siemens-type, furnaces is difficult by the nature of their operation, and, when economic pressure does demand a saving in fuel, the recuperator and the waste-heat boiler will be the two logical devices for the purpose. Recuperators are being constantly improved, both in this country and abroad, and excellent designs will be available, whether they be of refractory tile, carborundum tubes, or metallic baffles of heat-resisting alloy.

TABLE 6 POSSIBLE FUEL SAVINGS WITH PREHEATED COMBUSTION AIR

Temperature of air preheat, F	200	400	600	800	1000	1200	1400	1600
Saving in fuel consumption, per cent	4.3	10.8	14.8	19.2	23.5	27.5	31.0	33.6

An idea of the savings possible with recuperation can be gained from Table 6 which shows the percentage saving in fuel consumprion resulting from preheating the combustion air to various temperatures.

In conclusion, the statement is repeated that, to select the proper fuel for industrial heating furnaces intelligently, it is essential to understand the chemical and metallurgical requirements as well as the cost of the heat. A small percentage of rejected material in its semifinished state will frequently more than offset the difference in cost of the fuels under consideration. At the same time, by engineering based upon the latest developments in control, the cheaper fuel can often be successfully applied to the requirement.

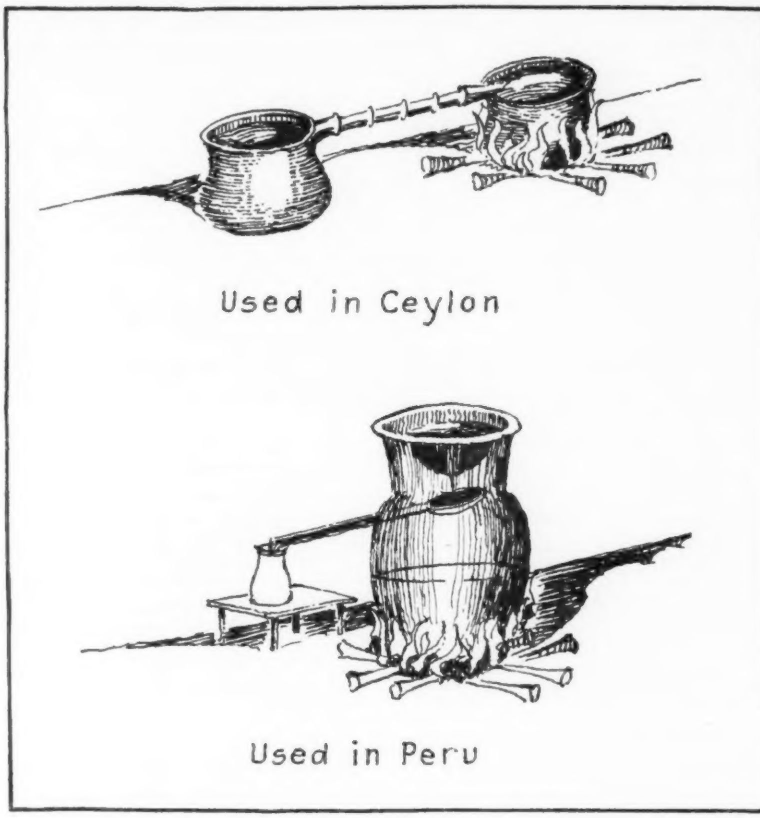


FIG. 1 ANCIENT STILLS USED IN CEYLON AND PERU

POWER-PLANT REQUIREMENTS *of a* DISTILLERY

By HIRAM L. WALTON

SMITH, HINCHMAN & GRYLLS, INC. DETROIT, MICH.

VARIOUS compounds are commercially produced by distillation, and the plants in which this process is performed are technically distilleries. However, many plants employing the distilling process are not commonly so designated—an oil refinery, for instance. The term "distillery" has, by common usage, come to refer specifically to a plant producing alcohol. In the popular mind, the term refers more particularly to a whiskey distillery, a plant producing distilled spirituous liquors from grain for beverage purposes. It is to the power requirements of this type of distillery that our further consideration is given.

Some understanding of the processes carried on in a whiskey distillery is desirable in developing the requirements for power incidental to the process. The art of distillation itself, in producing spirituous drinks, has been known from time immemorial. Fermented liquors, including wine, beer, and mead, were familiar to the ancients. Distillation appears to have been known to the Chinese from a period in the remote past, and they may, perhaps, have distilled wine, thus obtaining alcohol from it; but the usually accepted belief is that Arabian chemists were the discoverers of alcohol from wine. Knowledge of the art of distillation in those ancient times seems to have been widespread and descriptions of ancient and primitive stills have been found which were in use by the Alexandrians, the Kalmuck Tartars, and people in Ceylon and in Peru (Fig. 1).

Contributed by the Power Division for presentation at the Semi-Annual Meeting, St. Louis, Mo., June 20–24, 1938, of The American Society of Mechanical Engineers.

DESCRIPTION OF PROCESS

Alcohol, as a substance, is a compound of carbon, hydrogen, and oxygen, which the chemist designates as C_2H_5OH. This is ethyl alcohol and is the best known member of a series of alcohols that include methyl, propyl, butyl, and amyl. The ethyl alcohol with which we are concerned in a distillery is obtained by the fermentation of sugar in the form of dextrose. This sugar does not occur in this form in the grain used by a distiller but is present as starch and is converted to dextrose by the

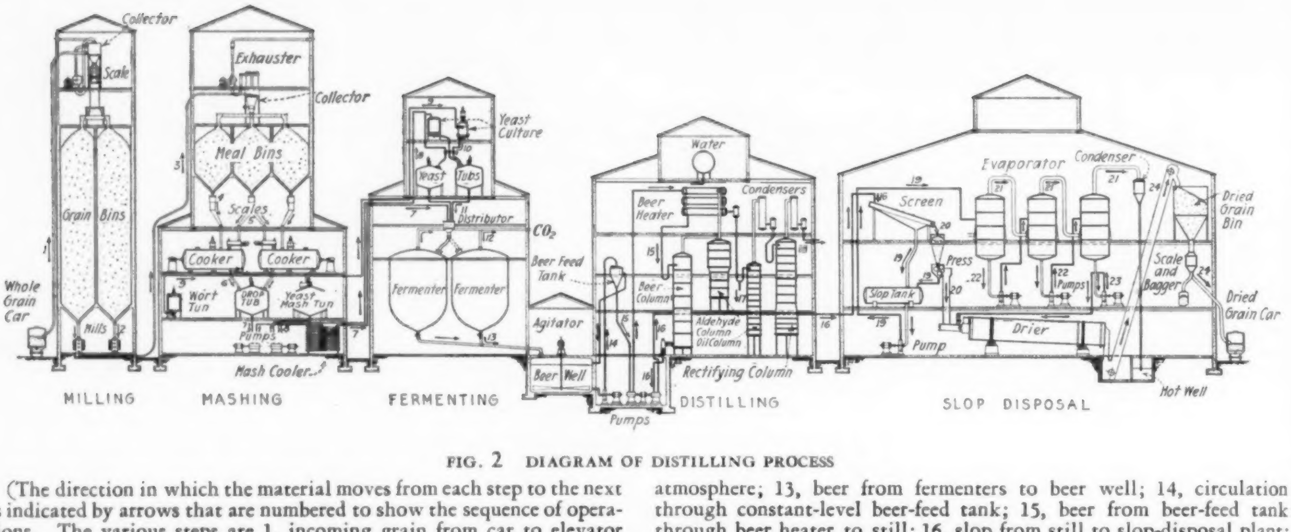


FIG. 2 DIAGRAM OF DISTILLING PROCESS

(The direction in which the material moves from each step to the next is indicated by arrows that are numbered to show the sequence of operations. The various steps are 1, incoming grain from car to elevator bins; 2, grain from bins to mills; 3, ground grain from mills to meal bins; 4, meal through scales to cookers; 5, ground malt from bins through scale and mixers to cooker; 6, mash from cookers to drop tubs; 7, mash pumped from drop tubs through cooler to fermenters; 8, yeast mash pumped to yeast tubs; 9, malt extract pumped from wort tun to pure-yeast culture machines; 10, pure-yeast culture machines to yeast tubs; 11, yeast tubs to fermenters; 12, CO_2 to dry-ice plant or vented to atmosphere; 13, beer from fermenters to beer well; 14, circulation through constant-level beer-feed tank; 15, beer from beer-feed tank through beer heater to still; 16, slop from still to slop-disposal plant; 17, high wine or new whiskey to drawing-off tanks for barreling; 18, neutral spirits or alcohol to receiving and storage tanks; 19, thin slop from screen to evaporator; 20, grain from screen through press to drier; 21, vapors through multiple-effect evaporator; 22, evaporator feed between effects; 23, syrup or concentrated slop from evaporator to drier; and 24, dry grain from drier to bagger and car for transportation to compounders of stock food.)

action of the malt which is added during the course of the mashing process.

In this part of the process, the meal obtained by grinding the grain is mixed with water and cooked by steam to expand the cells and gelatinize the starch. This forms the "mash" which is then saccharified by the malt, the resulting liquid being known as the "wort." With the addition of yeast, this wort ferments to form the "beer." The application of this term is not the same as the similar one used in the brewing industry.

Alcohol is driven off from the beer in a continuous distilling unit by the application of steam. As recovered from the beer column of the unit by condensing, it is termed "high wine" which, by aging in oak barrels, takes on color and flavor with some change in the foreign compounds associated with it and becomes the whiskey of commerce. If alcohol in a purer and more concentrated form is required, the high wine is redistilled in the rectifying column of the unit.

The apparatus in which the distillation is accomplished has been spoken of as a continuous distilling unit and is steam-operated. Other types of stills are not continuous in their operation and some are not steam-operated, such as the pot still in which Scotch whiskey is made and which is direct-fired, generally with coke as a fuel. These types of still have but slight use in the distilleries of this country, and consideration is not given to their effect on the power-plant requirements.

BY-PRODUCTS

Although the production of alcohol is the primary objective in distillery operation, by-products are produced which have some effect on the economy of the process and much effect on the requirements for power and steam.

First is the spent grain that is marketed to compounders of stock food as distiller's grain. This is the grain remaining in the beer as suspended matter after the alcohol has been driven off and is the insoluble portion of the grain that remains when the starch has been removed. This dealcoholized beer with its grain content as it is drawn from the bottom of the still is known by the inelegant but descriptive term "slop." In the earlier days of the distilling industry in this country, slop was fed to cattle, and it was usual to find cattle sheds or feeding pens provided in connection with the distilleries of those times. With the increase of population about distillery centers and less toleration of nuisances, this method of slop disposal is no longer acceptable. It would take a herd of over 20,000 head to consume the slop from some present-day distilleries.

Now, the practice is to strain the grain from the slop and to dry it so that it can be readily transported and marketed. The effluent or "thin slop" that remains after the grain is removed contains soluble mineral salts and proteins that also have a value as a component of stock foods but not sufficient to warrant their recovery if stream-pollution regulations do not prohibit discharging this effluent into the drainage system of the district. Usually, however, such restrictions are in force, and it becomes necessary to dispose of this effluent otherwise. In the modern distillery, this effluent is concentrated in multiple-effect evaporators and mixed with the grain, the remainder of the moisture being removed by the grain driers. The disposal of this thin slop greatly increases the steam requirements and has an appreciable effect on any heat balance that is set up.

Carbon dioxide is given off in large volumes in the fermenting process and, with the use of closed fermenters, may be recovered and liquefied or made into dry ice. The recovery of this by-product materially increases the power consumption, amounting to as much as 10 per cent of the power required by the distillery.

The grain contains some vegetable oils which have a commercial value and may be recovered by degerming the corn before milling or by washing the grain with a solvent after drying. Recovery of the vegetable oil by either method is uncommon and the power and steam requirements are not greatly affected.

PLANT SERVICES AND FACTORS AFFECTING DESIGN

The sequence of the processes that have been described and the equipment required are shown by a conventional diagram, Fig. 2, the direction of material flow being indicated by arrows that are numbered to show the order of the various processes. In carrying out these processes in the modern distillery, saturated steam is required at 90 lb pressure for mashing and cooking,

at 60 and 20 lb for distilling, at 20 lb for thin-slop evaporation, and at 125 lb for grain drying. These pressures are taken as the service pressures at the power plant and some variation will be found in those actually required at the apparatus. Also, the grain driers are not necessarily operated by steam. They may be direct-fired which, of course, would have its effect on the heat balance.

Mechanical power is required for conveying, milling, agitation, and pumping. These requirements can be most conveniently supplied in the form of electric power using motor drives, although steam-operated prime movers can be used. More modern practice is to use motor-driven equipment outside the power plant.

After the steam and power requirements have been established, other factors, of course, affect the design of the power plant, such as the nature and cost of the fuel and the cost of construction and equipment as affected by the conditions under which the plant has to be built. These are usually considerations in the design of any plant, but some factors in the way of government regulations peculiar to distillery practice may have some effect on the design of the plant. In this country, a plant is not permitted to operate from midnight Saturday to midnight Sunday as a whiskey distillery. As an industrial-alcohol distillery, it may operate seven days per week. In the British Isles, mashing and distilling are not permitted to be carried on simultaneously, making it necessary to mash the first three days of the week and distill the last three days. Another factor influencing power-plant design is the opportunity for electric-power connections with other industries to utilize surplus power that may be generated in supplying exhaust-steam requirements or with public-service systems to supply emergency service or power deficiency or to utilize surplus power. This factor is determined largely by local conditions.

EXAMPLES OF DISTILLERY POWER PLANTS

It is not the intention to cover in this paper so academic a procedure as establishing the characteristics of a power plant and proportioning its equipment for any particular set of conditions but to present those factors that have been described as particularly influencing power-plant design. However, it is presumed that a brief description of the characteristics of some types of plant that have been built to meet these conditions would be of interest. In describing these plants, the capacities of the distilleries served are of some significance. Distilleries are rated in bushels of grain mashed per day. A bushel to the distiller is 56 lb regardless of the kind of grain. A yield of five proof gallons of alcohol per bushel of grain is considered fair distillery operation.

Quite representative of distilleries with power plants designed with respect to the conditions that have been described and the various factors influencing them are the distilleries of Hiram Walker-Gooderham & Worts, Ltd., at Peoria, Ill.; Walkerville, Ont., and Dumbarton, Scotland; and the distillery of Joseph E. Seagram & Sons, Inc., at Louisville, Ky. The Peoria, Dumbarton, and Louisville distilleries are new plants, the Dumbarton distillery being under construction at this time. The Walkerville distillery is an older plant but has been kept up to date, and further modernization of its power plant is now under way.

The Peoria distillery has a mashing capacity of 22,000 bu per day. It is a completely motorized plant, electric power being supplied by two noncondensing extraction turbines of 1500 kw capacity each. These turbines are supplied with steam at 250 lb per sq in. gage pressure and 100 F superheat. They exhaust at 20 lb back pressure and provide for the extraction of steam at 90 lb pressure. This plant is interconnected with the power system of the Central Illinois Light and Power Company under an arrangement that provides for the transfer of electrical energy in either direction as the load conditions for steam and electric power may require. Usually the flow of power is to the power company's system, a surplus being generated. The diagrams appearing in Figs. 3 and 4 showing the utilization of steam and electric power are particularly applicable to this distillery.

Seagram's distillery at Louisville has a capacity of 10,000 bu per day and is particularly interesting in comparison with other distilleries in that a considerable part of the equipment is provided with steam-turbine drives. These turbines are supplied with saturated steam at 400 lb pressure, some exhausting at 90 and some at 10 lb back pressure. This arrangement has reduced the requirements for electric-power generation and the power plant is equipped with one noncondensing turbogenerating unit of 600 kw capacity with throw-over connection to the local power company's system for emergency service.

The Walkerville distillery has capacity for mashing 3500 bu per day. When the work now under way is completed, the power plant will be equipped with one 500-kw condensing turbogenerating unit and one 100-kw extraction condensing unit. These turbines are supplied with saturated steam at 200

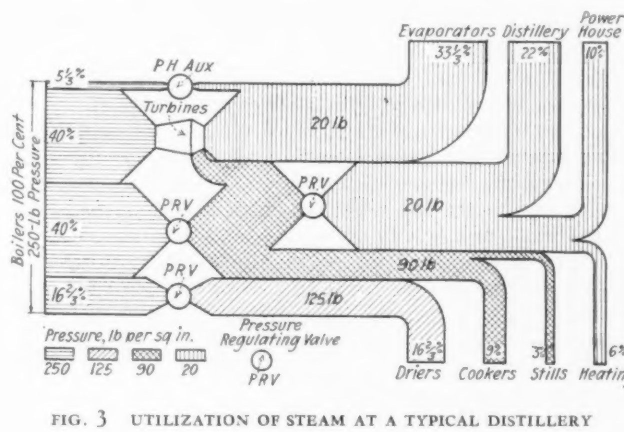


FIG. 3 UTILIZATION OF STEAM AT A TYPICAL DISTILLERY

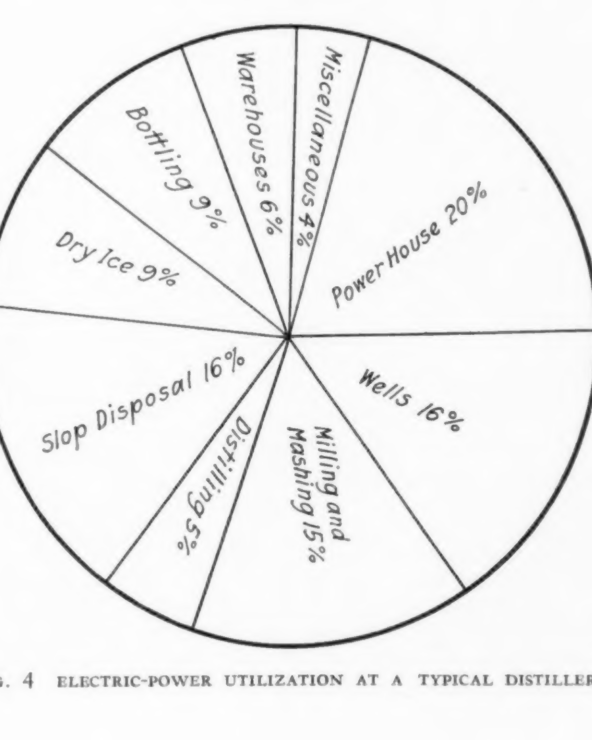


FIG. 4 ELECTRIC-POWER UTILIZATION AT A TYPICAL DISTILLERY

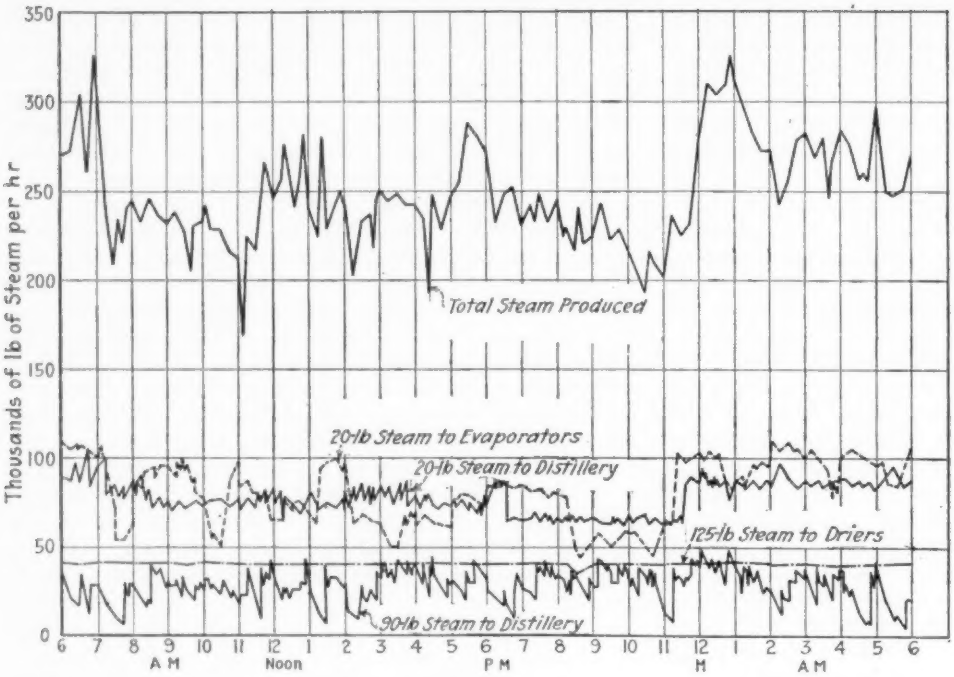


FIG. 5 TYPICAL 24-HR STEAM LOADS, CORRESPONDING TO A DAILY PRODUCTION OF 91,000 PROOF GALLONS

lb pressure and will supply extracted steam at 60 lb. This plant has an advantageous situation in supplying power and steam to the distillery by reason of also operating to pump the water supply for the city of Walkerville. The extraction turbine is normally operated when the distillery is running, and the condensing unit held in reserve for stand-by service.

The Dumbarton distillery, in the capacity of its equipment, would correspond to a distillery rated at 5000 bu. Its rating is only half of this, however, by reason of the limitation on mashing and distilling simultaneously. Because of this limitation, demands on the power plant for steam and electric power are somewhat reduced. The plant is equipped with one 500-kw noncondensing turbine supplied with steam at 250 lb pressure and exhausting against 100 lb back pressure. This plant has no connection with any other source of power supply and is provided with two Diesel-engine-driven generating units of 125 kw capacity each for emergency service and flexibility in balancing the steam- and electric-power requirements.

Considerable variation is seen in the type of power plants that have been provided to serve these several distilleries. To a great extent, this has been due to the provisions for the disposal of the thin slop. At the Peoria distillery, it is recovered by evaporation and, at the other distilleries, it is discharged into the adjacent rivers. The arrangements that it has been possible to make for interconnection with the local power systems have also had their effect, also the opportunity to use the power plant for other than distillery services, as municipal water-supply pumping at the Walkerville distillery.

INFLUENCE ON DESIGN

From the standpoint of power-plant design and the factors affecting it, the Peoria and Louisville distilleries, as two modern installations, offer a decided contrast. Each is basically representative of the type of plant that economically meets the requirements for steam and power. They have the common objective of a balance between the process-steam requirements and the exhaust steam that is produced in supplying the requirements for power. Both plants come reasonably close to meeting this objective.

By reference to Fig. 3, it may be observed that of the process-steam requirements for the Peoria distillery, 71 per cent is at 20 lb pressure, 12 per cent at 90 lb, and 17 per cent at 125 lb. These requirements are determined by the characteristics of the process equipment and may be varied somewhat in its selection. For example, a significant steam saving can be made by operating the distilling equipment entirely on the 90-lb service instead of partially on the 20-lb, and the driers can be operated at 90 lb, it being a matter of installed drier capacity.

Extraction turbine-generating units were selected for the Peoria plant, extracting and exhausting at 90 and 20 lb, respectively. The steam-supply system of which they are a part is shown diagrammatically in Fig. 6. The boilers operate at 250 lb working pressure and 100 F superheat, this being sufficient to give dry exhaust steam. The question may well be raised if a higher boiler pressure, say 400 lb, would not be preferable. It would certainly result in the generation of more power, which, if sold at normal power rates through interconnection with the power company, could be expected to show a profit. Possibly a return could even be earned on the added cost of higher pressure construction at the rate received for power delivered to the power-company's system, which is slightly under the equivalent coal cost to that company.

Again, by reference to Fig. 3, it will be noted that the 20-lb

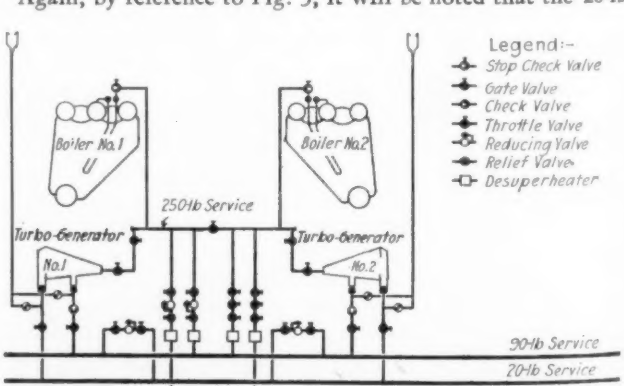


FIG. 6 STEAM-SUPPLY SYSTEM AT A TYPICAL DISTILLERY

steam for the evaporators is some 50 per cent of the steam required at this pressure and one third of the total by the plant. If the evaporator plant is not required to dispose of the thin slop, the balance between power requirements and use of exhaust steam is much different from the situation at the Peoria distillery. Also, the dry-ice plant, as operated at the Peoria distillery, has a considerable effect on the electric-power requirements, this service (see Fig. 4) amounting to 9 per cent of the total power used.

The Louisville distillery is representative of a plant in which dry-ice manufacture and evaporation of thin slop are not factors affecting the characteristics and capacity of its power plant. Equipment in this plant has been previously described, and since no opportunity exists to dispose of the electric power that might be generated in excess of the distillery requirements, the major part of the steam is exhausted at 90 lb, the requirements for steam that is exhausted at 10 lb being relatively small. The boilers in this plant are not equipped with superheaters. With the 400-lb saturated steam for the turbines, the 90-lb exhaust is slightly superheated. To accomplish a balance between process-steam and power requirements in this plant, it is necessary that sufficient drier capacity be provided for operation at 90 lb.

CONCLUSION

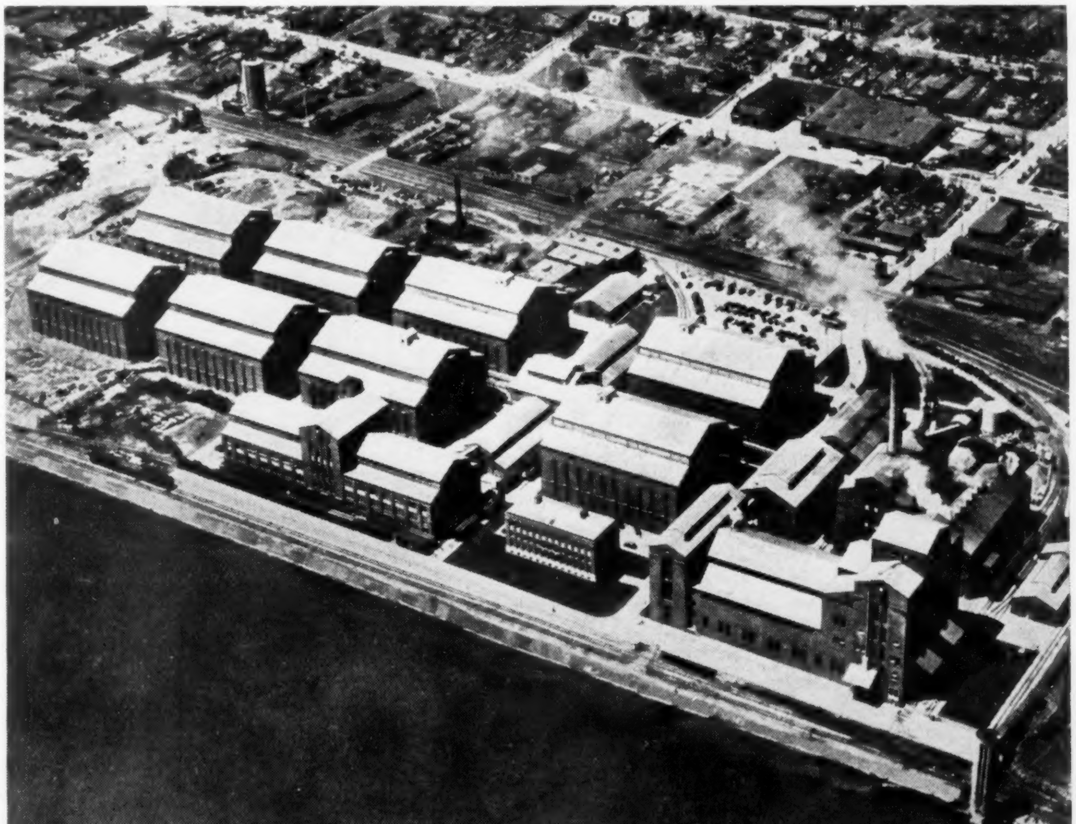
Some factors for establishing the characteristics and capacity of the equipment entering into the design of a distillery power plant can be derived from the curves reproduced as Fig. 5. They would apply particularly to a distillery of above the average capacity, using motor-driven equipment and evaporating the thin slop. They would have to be used with considerable judgment in studying the requirements and design for any particular plant.

Process-steam requirements shown by the four curves in the lower part of Fig. 5 do not equal the total steam produced, as shown by the uppermost curve. These curves apply particularly to the Peoria distillery, and the difference, aside from some condensation losses and errors in recording instruments, is represented by the steam used in the water-softening process for heating this water to boiler-feed temperature.

Water supply for the distillery is obtained from several wells having a considerable variation in hardness. To control the softening process, water is used directly from one well. This is at ground-water temperature, materially increasing the steam required for feedwater heating. An opportunity to install heat exchangers exists so that this cold feedwater supply can recover some of the heat lost in process condenser water and cooker blowdown. Only a part of the process steam can be recovered as condensate; a large part of the boiler feed has to be supplied as makeup.

The curve of total steam requirements is characteristic for the boiler load and shows the variations in load that have to be met. Although these are considerable, they are no more than the combustion-control equipment can handle effectively.

Comparatively the modern distillery, in its utilization of steam and electric power and in its facilities for providing these services, is an efficient and economical chemical plant. Thermally there is considerable margin between the efficiencies obtained in practice and those possible. The extent to which improvements in future distillery construction and operation will reduce this margin is largely a matter of cost of construction and equipment balanced against the cost of fuel.



BIRDEYE'S VIEW OF MODERN DISTILLERY

RESISTANCE TESTS ON PIPE

Conforming to Specifications of the American Foundrymen's Association

By ARTHUR NUTTING

AMERICAN AIR FILTER COMPANY, INC., LOUISVILLE, KY

TO DETERMINE pressure losses in exhaust systems, designers usually refer to one of several commonly used charts on which is plotted the friction resistance for 100 ft of pipe against the air volume. Some of these charts were constructed on the basis of a friction coefficient determined from data taken on one size of pipe, while others were constructed on the assumption of a friction coefficient. Again, most of these charts are made on the basis of the following formula:

$$H = fLv^2/2gD$$

where

H = loss of head, ft of air
f = friction coefficient
L = length, ft
v = velocity, fps
D = diameter, ft

The difference between the charts using this basic formula amounts to a change in exponents for v and D. In all cases, the charts are intended to give friction values for pipe of the same character as that commonly used in blowpipe work, and yet the charts show a violent disagreement in the amount of friction to allow for this piping.

This research work on pressure losses of exhaust systems was suggested by the Industrial Hygiene Codes Committee of the American Foundrymen's Association, of which James R. Allan is chairman, and by the Engineering Committee of the Dust Control Equipment Association. The former committee is now completing a code on the fundamentals of design, construction, operation, and maintenance of exhaust systems, which will be issued as a code of recommended good practices to the foundry and allied industries in the United States and Canada, and for which these data are required The latter committee is establishing uniform engineering practices to be used by the various members of its association, in which this information is also required.

Because of the great variation in some of the more commonly used charts and formulas on friction resistance, it was obviously desirable to determine definitely once and for all the friction losses in piping systems. Accordingly, four different sizes of galvanized sheet-metal pipe, 4, 6, 8, and 12 in. in diameter, were fabricated to the American Foundrymen's Association's specifications. All pipes were made 75 diameters long. Longi-

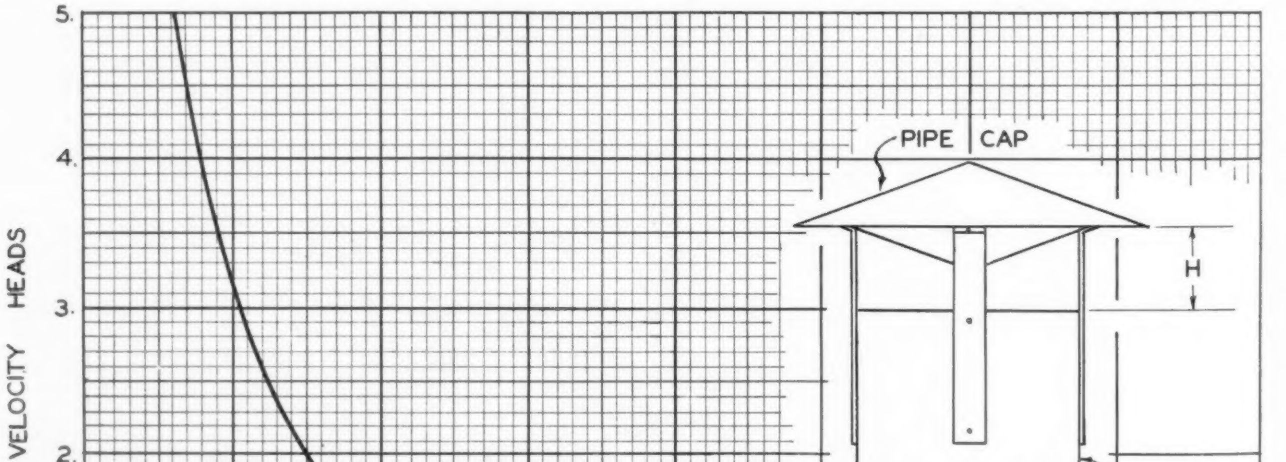


FIG. 1 VARIATION IN THE RESISTANCE OF PIPE CAPS

tudinal seams were lapped 1 in., riveted on 3-in. centers, and soldered. The girth joints were also lapped 1 in., riveted on 3-in. centers, and soldered; the girth joints being 35 in. apart in all ducts. Seven-piece 90-deg elbows were constructed in the same manner, the inside radius of the elbows equaling 2 pipe diameters. The resistance of all sizes of elbow was found to be equivalent to that of 12 diameters of pipe. This pipe was in all respects representative of that used in well-constructed exhaust systems. The chief difference in construction will probably be that in some cases a lock seam instead of a riveted one might be used. This would probably lower the friction coefficient slightly.

Further tests were made upon the resistance losses caused by exhaust caps, the design of which is shown in Fig. 1. In testing the resistance, each size of cap was placed at varying distances from the end of the pipe, and, according to the data taken, the friction loss for any size of cap varies only with the distance it is spaced from the end of the pipe. The curve of Fig. 1 illustrates how this resistance varies, and it is obvious that the cap should be located at a distance of at least 0.7 pipe diameter from the end of the pipe.

Fig. 2 is a pipe-resistance chart that has been compiled from the data taken on the various pipes manufactured as described in a preceding paragraph. Comparison with other charts shows the resistance to air flow to be less than the values commonly used. Our data indicate a friction factor for this piping of 0.0051 in. water gage, and also indicate that the friction loss varies directly as $v^{1.954}$ and inversely as $D^{1.19}$. These exponents are in close agreement with the often used $v^{13/7}$ and $D^{9/7}$. The chart bearing closest to the data we have taken is that published by R. J. S. Pigott[1] in August, 1933. Other commonly used charts give friction losses from 25 to 50 per cent higher than we have found.

In lieu of a chart or formula, the common practice in calculating friction losses is to assume that 55 diameters of piping cause a resistance equal to one velocity head. Table 1 shows

TABLE 1 NUMBER OF DIAMETERS CAUSING A LOSS OF 1 VELOCITY HEAD IN VARIOUS SIZES OF PIPE

	Velocity, fpm				
Pipe size, in.	2000	3000	4000	5000	6000
4	46.5	48.0	48.0	48.5	49.0
6	50.0	51.5	52.5	52.5	53.0
8	54.5	56.5	56.5	56.5	57.0
12	57.0	59.5	59.5	60.0	61.0
16	60.5	63.0	63.5	64.0	65.0
24	66.0	67.0	68.5	69.0	69.0

the number of diameters of various sizes of pipe required to cause a loss of 1 velocity head. From this table, it is seen that a 50-diameter value would be a safe choice when none of the piping is over 8 in. in diameter, but, if the piping includes sizes from 4 up to 24 in., an average of about 55 to 57 diameters could safely be used because the higher resistance of the smaller pipe would balance the lower resistance of the larger one.

[1] "The Flow of Fluids in Closed Conduits," by R. J. S. Pigott, Mechanical Engineering, August, 1933, pp. 497–501 and 515.

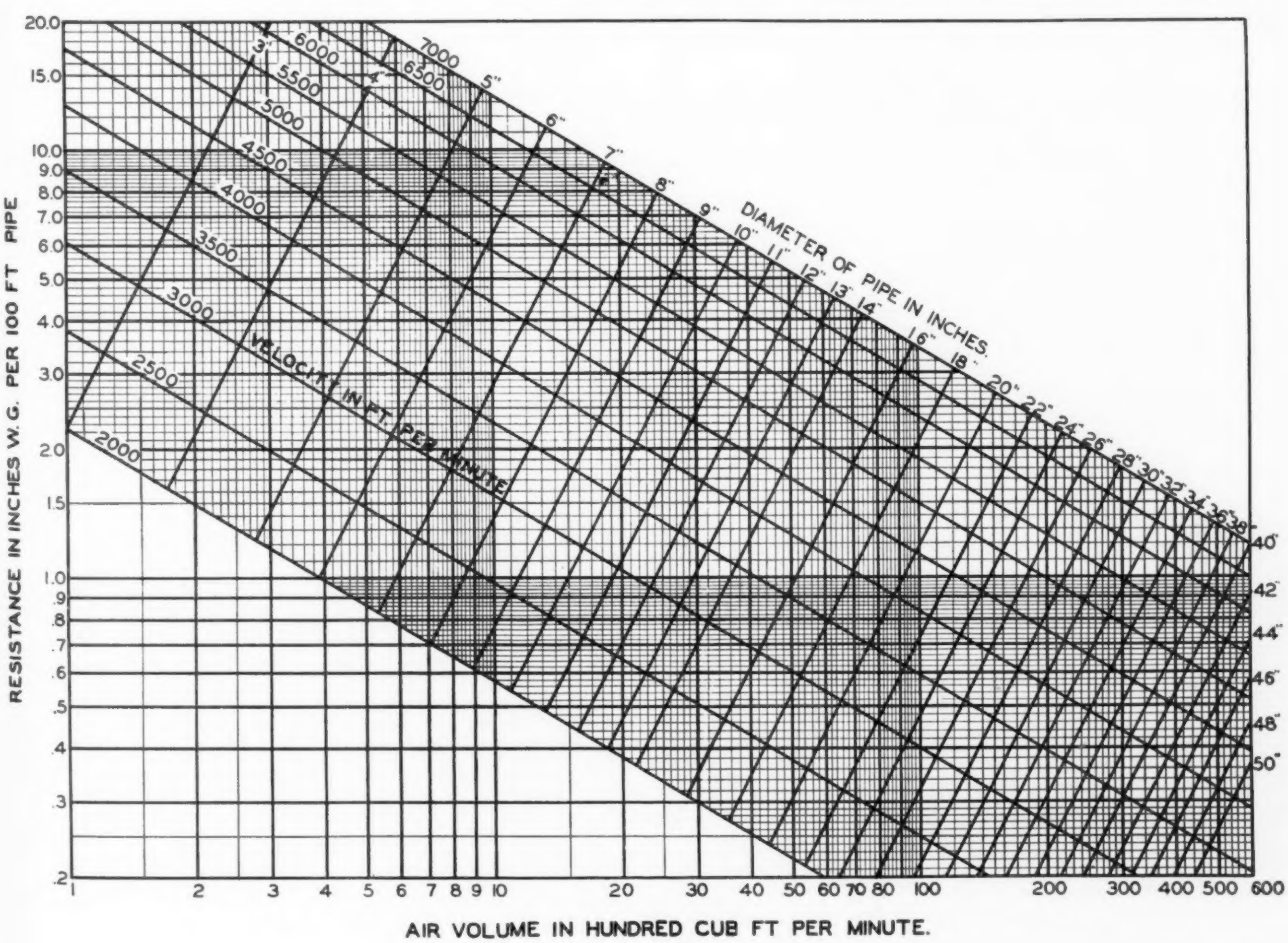


FIG. 2 PIPE-RESISTANCE CHART

Gas-Engine-Powered
OIL-PUMPING STATION

By FRITZ KARGE

UNION OIL COMPANY OF CALIFORNIA, LOS ANGELES, CALIF.

IN 1936, the Union Oil Company of California discovered an oil field by bringing in a well about two miles southeast of the city of Santa Maria, Calif., and about six miles north of the Orcutt oil field, which has produced oil for some thirty years. Early last spring, production had increased to a quantity that required moving the oil by pipe line.

CONDITIONS AND REQUIREMENTS

To avoid a large expenditure for a new line, it was necessary to use an existing 8-in. line from Orcutt pump station to Avila shiploading plant, the terminus of the company's pipe lines from the Orcutt-Lompoc fields and from all San Joaquin Valley fields. This line, which is shown on the map that is reproduced as Fig. 1, was thoroughly overhauled and many of the screw collars were welded. Only $2^1/_4$ miles of new 8-in. welded pipe line were required to extend the existing line to the site in the Santa Maria field, selected for the main pump station.

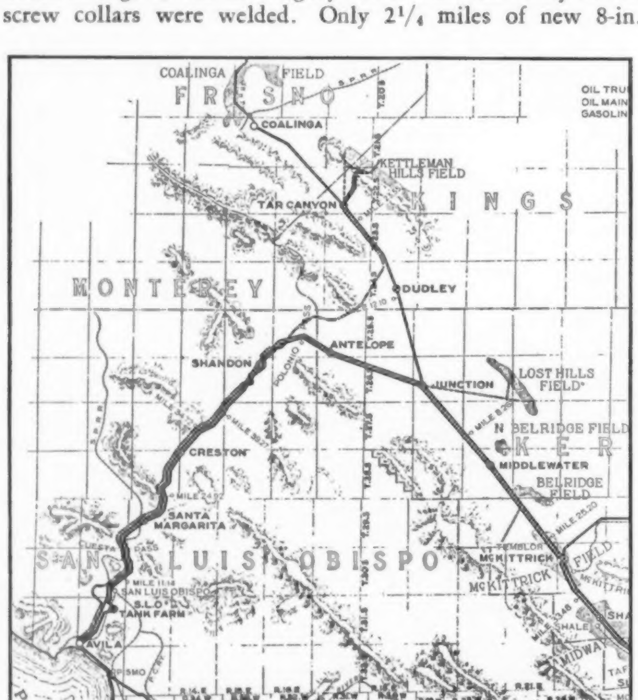


FIG. 1 MAP OF THE SANTA MARIA OIL FIELD AND THE SURROUNDING TERRITORY

Santa Maria oil is of 15 to 16 deg API gravity and its viscosity is 21,000 sec Saybolt Universal at 60 F. It contains approximately 21 per cent of gasoline, the remainder being largely asphalt, with only small quantities of the intermediate cuts, and it is produced at a temperature of 80 to 90 F. Experience and calculations indicated that heavy oil of this character must be pumped at temperatures of from 170 to 190 F, depending on the season, and at a rate of not less than 20,000 bbl per day. Daily production at that time was and still is below this rate and the oil must be accumulated in tanks for intermittent batch pumping. It cools in these tanks to approximately atmospheric temperatures, 60 F or even lower in winter. This made it necessary to provide efficient and easily controllable means for raising the temperature of the oil from 60 F, or less, to 180 at a rate of from 800 to 1000 bbl per hr. Because of its gasoline content, this oil begins to vaporize at approximately 120 F at atmospheric pressure. Booster pumps, therefore, must be supplied to force the hot oil into the suction of the main-line pumps under sufficient pressure to prevent vaporization at pumping temperature.

Following each period of pumping this heavy Santa Maria oil, the pipe line must be cleared with lighter oil that can be plugged out even after having been in the line long enough to cool to ground temperatures. Plugging out oil as viscous as Santa Maria crude oil, cooled to winter ground temperature, is nearly impossible. Light oil of 24 deg API gravity is available at Orcutt pump station and pumping operations must be scheduled there to follow immediately after a movement of heavy oil is completed from the new Santa Maria field in at least sufficient quantity to fill the whole line.

The distance from the pump-station site in the Santa Maria field to Avila, about 30 miles, is too great to move the heavy oil through an 8-in. pipe line by a single pumping. This made it necessary to build a second pump station at about mid-distance, at Summit, on a site owned by the company for many years. Here, only a small supply of good water, insufficient for steam operation, is available from a spring and additional water has to be procured from a dwindling supply in the neighborhood or it has to be brought in from a distance of about eight miles. In the Santa Maria field, sufficient water for industrial use is available but it is hard and requires excessive chemical treatment. Dry natural gas of about 1000 Btu per cu ft heat value is available at both locations from a company-owned pipe line and from a pipe line of the Santa Maria Gas Company at an economical rate.

TYPE OF EQUIPMENT CHOSEN

Because of these conditions and requirements, we chose for these new pump stations direct-fired heaters for heating the oil and natural-gas engines for driving the pumps. Rotary pumps were chosen for boosting the oil through the heaters and

Contributed by the Petroleum Division and presented at the Spring Meeting, Los Angeles, Calif., Mar. 23–25, 1938, of The American Society of Mechanical Engineers.

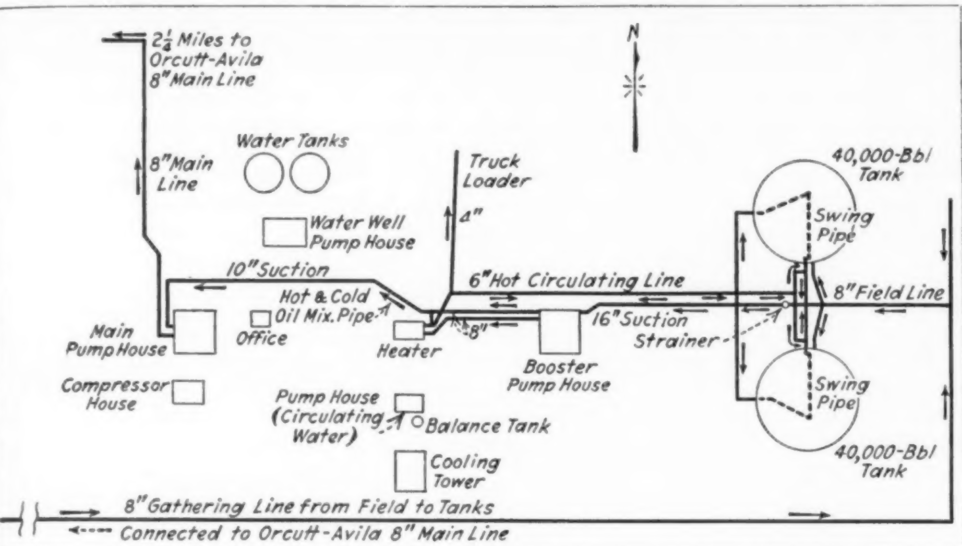


FIG. 2 SIMPLIFIED FLOW CHART OF THE SANTA MARIA PUMPING STATION

into the suction of the main-line centrifugal pumps. We had never before combined the individual units of this equipment for installation in a main pump station but have used them in combination with other types of machinery with entirely satisfactory results.

Centrifugal pumps have been used for light oil in main-line pump stations for many years but also for heavy oil in the last few years. For large movements, heavy oil must always be heated and, with such heating, the viscosity is reduced to a point at which centrifugal pumps can handle the oil without great reduction in volumetric and head capacities and in efficiency. Experience also has taught us that this type of pump, because of its constant impulse, plugs out a cold line easier than reciprocating pumps with a pulsating impulse.

For boosting the heavy, cold oil from the accumulation tanks through the heater and for effecting a suction pressure of 100 lb per sq in., gear-type rotary pumps were chosen, the oil being much too viscous for centrifugal pumps. A suction pressure of about 12 lb per sq in. is required to prevent vaporization of the hot oil. For good measure, however, and for other reasons, which will be given later, we decided on a suction pressure of 100 lb per sq in.

In addition, auxiliary equipment, such as cooling towers, water pumps, and two-stage natural-gas-engine-driven air compressors for starting the larger gas engines that drive the main-line centrifugal pumps, had to be chosen, as well as certain safety and automatic devices that our previous experience indicated as necessary or desirable. Having decided upon the type of equipment, the problem of combining the different units to a workable and efficient whole lay before us. The general arrangement of the Santa Maria pump station is shown in Fig. 2, and the direction of flow for the oil is indicated. The layout of the station was partially determined by the location of one oil well and the proposed site for a second well.

Storage Tanks. Two 40,000-bbl steel cone-top tanks were erected and inclosed within earth walls, space being available to the east for additional tanks. A 16-in. suction line, laid to grade, was run westerly from between these tanks, through the fire wall, and to the booster-pump house.

Booster Pumps. The two booster pumps, which are driven through speed-reducing gears by individual six-cylinder, four-cycle natural-gas engines, were placed in a pit 6 ft deep and protected with a steel house. One unit is capable of pumping up to 760 bbl per hr, the other up to 650 bbl. At maximum pumping rates, the pumps run at 310 and 460 rpm, respectively, and the engines at 1000 rpm. Provision is made for a third booster pump, giving one-half stand-by capacity, which is unnecessary at this time because of the intermittent operation. Discharge lines from the booster pumps are equipped with pressure-relief valves and with by-passes to the suction line and they are cross-connected so that either pump can send its stream to and through the heater. To reduce the pressure drop through the heater, however, only one booster pumps through the heater, the other by-passing it. Hot oil from the heater and cold oil from the other booster are brought together in a mixing pipe that leads to the suction of the two centrifugal main-line pumps.

Depending upon the temperature of the oil in the tanks and that required in the main line, the oil is brought to a temperature of from 225 to 275 F in the heater. Part of the hot-oil stream, from 100 to 200 bbl per hr, is returned through a flow-control bean to the tanks, being introduced either into the suction line close to the tanks or into the tanks through a pipe lying on the tank bottom, the end of which is located directly under the free end of the swing pipe in lowered position. This end of the swing pipe is belled out to reduce entrance head loss. This arrangement further improves suction conditions, particularly when the oil is low in the tanks. The flow bean permits close control.

Heater. The heater resembles a tube still, having three parallel passes of 4-in. tubes 21 ft long. Each pass contains 40 tubes, arranged in eight tiers above and in two tiers in the bottom of the furnace space. A maximum gross heat load of 23,000,000 Btu per hr can be placed on the heater. The furnace space is proportioned for burning heated Santa Maria crude fuel oil, its volume being 1.17 cu ft per lb of oil burned per hour. Forced draft is provided by a 6800-cu ft blower driven by a 5-hp electric motor. A combination burner supplied with several tips of different sizes and with a ring burner for gas, is used. A pressure of about 250 lb per sq in. is necessary on the tips for good atomization of the fuel oil and this is supplied by a $^1/_2$-in. rotary pump that is driven by a 1-hp motor and takes its suction from the heater. A pressure-relief valve safeguards the fuel-oil set, and quantity control is achieved by a by-pass around the pump. Gas is used for starting the heater and may be used entirely when sufficient gas becomes available. A thermal efficiency of from 75 to 78 deg is expected of the heater, such efficiency having been obtained in other units of similar design. No detail tests of this new heater have been made up to the present time.

Main-Line Pumps. The gears between the two 9 × 11-in. eight-cylinder four-cycle natural-gas engines and the two 4-in. six-stage oil-line centrifugal pumps have a ratio of 1 to 5.46 so that the engines turn at 532 rpm when the pumps turn at 2900 rpm, each delivering 500 bbl per hr against a discharge pressure of 800 lb per sq in., the suction pressure being held at 100 lb per sq in. by the booster pumps. Under favorable summer conditions, a maximum hourly capacity of 600 bbl can be attained

by each pump, operating at 3000 rpm, with the same pressure conditions as for the smaller capacity. For this pump speed, the engines have to turn at 550 rpm. At this maximum load, the engines will have a piston speed of 1000 fpm with a brake mean effective pressure of 68 lb per sq in., whereas, with the smaller normal load, the piston speed and brake mean effective pressure are 975 fpm and 60 lb per sq in., respectively.

As previously stated, a suction pressure of 100 lb per sq in. was adopted as a full measure of safety against vaporization but also to keep the piston speed and brake mean effective pressure of the large engines at the entirely safe values given in the preceding paragraph. Incidentally, a somewhat higher efficiency value applies at the lower net head on the pumps. The load on the engines driving the booster pumps is light enough to give equally satisfactory piston speed and brake mean effective pressure so that all loads are apportioned nicely to the power capacities of the engines. Later, when operations are less intermittent than now, a third pumping unit of equal size will be installed, so that a stand-by capacity of one half the pumping rate will become available.

Cooling System. The cooling water for all gas engines is handled through a common plant, located between the heater and the cooling tower, on the south side of the heater. The water-pump house has a slightly depressed floor, for better suction. One centrifugal pump circulates softened water through the coil, through all engines including the gasoline engines that drive the circulating pumps, and to a small balance tank, taking suction therefrom. The second centrifugal pump pumps raw water over the cooling tower. The third, which is electric-motor driven, is a stand-by to the other two and is equipped to start automatically if the engine circulating-water pump should stop. The cooling water is furnished to the engines at a temperature of 140 to 145 F and enough is supplied to effect a temperature rise of about 10 F. A temperature controller with its bulb in the suction of the circulating-pump controls the flow through a diaphragm-actuated motor valve placed in a by-pass, between the hot-water return and suction lines, effecting the shunting of a larger or smaller quantity of hot return water to the pump suction. The proper temperature having once been reached, practically no manipulation of valves is necessary to hold it.

The same pump and engine units were installed at Summit, but they were all placed in one pump house, giving a compact arrangement. A heater of identical design was built. No large oil tanks were erected but only a 1600-bbl tank, floating on the main pipe line just ahead of the point where the line connects to the suction of the booster pumps. As at Santa Maria, these pumps boost the oil through and around the heater and through a mixing pipe to the suction of the centrifugal pumps. A cooling tower and a 1000-bbl water tank complete the equipment, and a small, electric-motor-driven, float-controlled, centrifugal pump keeps the tank filled from the adjacent spring.

Auxiliary Equipment. All gas engines are equipped with tachometers, air filters, temperature indicators for water and oil, water and oil pressure gages, and with apparatus giving an alarm signal when water or oil temperature rises to higher than desired, but still safe, values, warning the operators to take remedial steps. The heaters are equipped with cold and hot oil temperature recorders.

Strainers ahead of the booster pumps protect all units. Connections are available to permit circulation of hot oil through all pipe lines between the tanks, the heater, and all oil pumps. The customary suction and discharge pressure gages, check valves on the discharge lines of the centrifugal pumps, expansion joints in the hot-oil lines, and victaulic couplings on many fittings to obtain flexibility further safeguard pumps and pipe lines. Curves were furnished to the operators indicating the capacities of the booster pumps for different engine speeds and the capacities of the main-line pumps for different pressures and engine speeds. These serve merely to enable the operators to balance the operation of the four pumps at each station. The actual pumping rate is determined by tank gaging. Automatic gages are available for hourly checks, dispensing with the necessity of the operators climbing to the top of the tanks.

STATION OPERATION

Recently, an 8-in. line was installed to the tanks at the Santa Maria station for gathering oil from an area southwest of the station. This line was connected also to the Orcutt-Avila main line at a point to the south of the junction of the discharge line from the station with the main line. By providing also the necessary valves in the main line and cross connections in the pump station, it is now possible to take the Orcutt light oil to the heater at Santa Maria station, through this gathering line. From 15,000 to 20,000 bbl of Orcutt oil is heated at Santa Maria station and pumped through the line to Avila, bringing the whole line to the proper temperature before moving any heavy Santa Maria oil. "Plugging-out" difficulties have thus been practically eliminated. The temperature of the oil is raised by 15 F per hr. Summit station boosts the stream through the heater and by the time the heavy oil arrives, all gas engines have been warmed up so that they will fall smoothly in line.

To shut down, the Santa Maria heater is turned off first and cooled. This takes about $^1/_2$ hr. Then, the pumps are stopped and Orcutt begins to clear the line with light oil heated to about 110 F to prevent sudden contraction stresses. The Summit heater remains on the line with gradually reduced fire until the Orcutt oil arrives. It is then turned off but the main-line pumps handle the stream until the Orcutt oil reaches Avila. Then Orcutt pumps alone.

CONCLUSION

One of the most satisfactory operating features of the stations is the facility and certainty with which the oil can be brought to any desired and practicable temperature. Each station is operated by three shifts of two men each. The ease with which the operators became familiar with the equipment was gratifying, and we are pleased by their general opinion that these new plants are easier to operate than steam pump stations. Mechanical maintenance and repairs are the duty of a crew of pipe-line mechanics which has its headquarters located at San Luis Obispo.

All equipment at these stations being new, maintenance costs have not yet been established. Fuel consumption at Santa Maria is somewhat higher than at our steam plants, largely because of the necessity to raise the temperature of the oil through 100 F or more. The load on the heater at Santa Maria and, therefore, the fuel consumption will decrease when operations become more continuous, since the oil will not remain in the tanks long enough to cool to atmospheric temperature. Heater- and engine-fuel costs are about the same as boiler-fuel costs at steam plants.

Detail designs of steam-operated pumping plants for these stations were not made. The units of necessary equipment, however, were listed and priced. The cost of such steam plants would have been somewhat higher, possibly 15 per cent. We feel certain that the over-all cost of these pump stations with direct-fired heaters and gas-engine-driven pumps will be lower than that of steam-operated plants of comparable size and for comparable service.

Practical Applications of

MOTION-STUDY RESEARCH

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WHEREVER manual work is performed, the problem of finding the easiest and most economical way of doing the task is always found. Because a large percentage of factory and office work is manual, much thought has been given to the improvement of labor effectiveness in industry. Since all "manual work" is done by the hands or other parts of the body, study of body movements has been found to be a valuable approach to the problem of finding better and less fatiguing ways of doing work. This study to eliminate all unnecessary motions and build up a sequence of the most useful motions is known as motion study.

Not only is it highly desirable for the worker himself to know how to work effectively, but it is equally important that those who design the equipment, lay out the work, and supervise the operations have a knowledge of the principles of motion economy. It is as much the task of the engineer to build the machine to accommodate the person who is to operate it as it is to build it to perform specific mechanical functions. Considerable information is now available which can be used in working out effective methods of doing work. Some examples of these more or less basic data will be presented and typical cases will be included to show how such information may be applied in actual factory operations.

From the anaylsis of the movements of the various members of the human body performing many different kinds of work, it has been found that all hand movements can be divided into 18 different well-defined classes. These fundamental motions or therbligs[1] are widely known and will be used in this paper. Therblig is a word coined by Frank B. Gilbreth to designate the subdivisions or events that he thought common to all kinds of work. Although the 18 therbligs are not all pure or fundamental elements in the sense that they cannot be further subdivided, they, perhaps, are the best classification of hand motions that we have. Moreover, they are well known and are widely used for motion analysis and work simplification in industry.

A brief explanation[1] of some of them will be given here by referring to the simple operation of picking up a fountain pen from the usual form of fountain-pen desk set, writing, and returning it to its holder. This method is shown, step by step, in the first column of Table 1, while the fundamental motions or therbligs are given in the second. The 18 fundamental motions, a few of which have just been described, form a basis for studying manual work of all kinds.

A tremendous amount of effort is wasted in industry because, in so many instances, each job or operation is considered as a special case, and little or no use is made of basic or fundamental data bearing on the particular problem.

[1] For definitions and more complete information about the therbligs, see "Motion and Time Study," by Ralph M. Barnes, John Wiley & Sons, Inc., New York, N. Y., 1937.

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TABLE 1 FUNDAMENTAL MOTIONS OR THERBLIGS USED IN WRITING

Steps used in writing	Name of fundamental motions or therbligs
Reaches for pen	Transport empty
Grasps pen	Grasp
Carries pen to paper	Transport loaded
Positions pen for writing	Position
Writes	Use
Returns pen to holder	Transport loaded
Inserts pen in holder	Pre-position
Lets go of pen	Release
Moves hand to paper	Transport empty

For example, several researches[2] show that continuous curved motions should be used instead of abrupt changes in direction of the hand. In many kinds of work, the application of this principle would be simple and result in increased output with less fatigue on the part of the operator.

A simple hand motion such as drawing a straight line by moving a pencil back and forth across a sheet of paper consists of the following parts: Transport loaded, away from the body; stop and change direction; and transport loaded, toward the body. As the hand starts to move, say away from the body, it accelerates then moves at a uniform velocity for some distance, and decelerates until it comes to a full stop. If the motion is reversed, the hand moving toward the body, the above components of the movement are repeated; the hand accelerates, moves at a uniform velocity, and a retardation takes place until the hand comes to a stop. Our studies show that as much as 24 per cent of the time for such a motion may be required for the stop and change direction.

FOLDING PAPER

The following example shows how the substitution of a smooth curved motion for abrupt changes in direction in creasing the fold in sheets of paper resulted in a substantial reduction in time. The operation is that of folding rectangular sheets of paper, varying in size from 3 × 5 to 12 × 15 in. folded, in the middle. Although several million of these sheets of paper are folded per year, it was found to be more economical to fold them by hand than by machine, because of the many different sizes that are used.

Old Method. The operator, holding a smooth piece of bone in the palm of her right hand, Fig. 1, grasped the lower right-hand corner *A* of sheet of paper to be folded. She folded this end over to point *B* where the two hands matched or lined up the two corners. Then, swinging the right hand away from

[2] "Time and Motion Study," by E. Farmer, Industrial Fatigue Research Board Report No. 14, His Majesty's Stationery Office, London, 1921, pp. 36–40; also "An Investigation of Some Hand Motions Used in Factory Work," by R. M. Barnes, University of Iowa Studies in Engineering, Bulletin No. 6, University of Iowa, Iowa City, Iowa, 1936, pp. 48–51; and "Studies of Hand Motions and Rhythm Appearing in Factory Work," by R. M. Barnes and M. E. Mundel, University of Iowa Studies in Engineering, Bulletin No. 12, University of Iowa, Iowa City, Iowa, 1938, pp. 12–18.

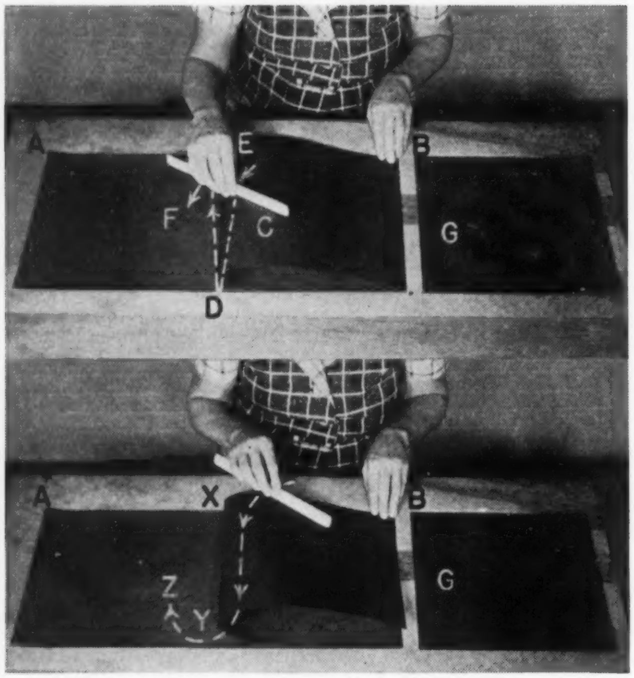

FIG. 1 PATH OF THE HAND IN CREASING A FOLDED SHEET OF PAPER

(The old method is shown in the upper view and the improved method in the lower.)

body and using the bone as a creasing tool, she struck the folded sheet of paper at *C* with the bone, creasing the fold from *C* to *D*. At *D*, she stopped and changed direction abruptly, doubling back and creasing the entire length of fold from *D* to *E*. At *E*, the hand again changed direction and swung around to *F* where the end of the bone was inserted under the edge of the creased sheet to assist the left hand in placing it on the pile of folded sheets at *G*.

Improved Method. The operator grasps the lower right-hand corner *A* of the sheet of paper to be folded. She folds this end over to point *B* where the two hands match or line up the two corners. She then moves the right hand through a smooth S-curve, the bone striking the paper and beginning to crease at *X* and ending at *Y*. Thus, the entire crease is completed with a single stroke. The hand then swings around in a curved motion from *Y* to *Z* where, as in the old method, the end of the bone is inserted under the creased sheet to assist the left hand in placing it on the pile of folded sheets at *G*.

Results. By using the improved method described above, only one creasing motion was required to complete the cycle instead of two, one short and one long. Moreover, in the improved method two curved motions of the hand were used instead of two complete change directions and one 90-deg change direction in the old method.

A micromotion study of these two methods showed that 0.009 min was required to crease the fold by the old and 0.005 min by the improved method. The improved method of creasing the fold plus some other changes reduced total time from 0.058 to 0.033 min per cycle, a 43-per cent saving.

PAINTING REFRIGERATORS

In some cases, it is possible to save material as well as time by the proper application of motion-economy principles. Let us consider the operation of painting, with a spray gun, the enclosed motor unit of an electric refrigerator. The unit had a number of irregular projections and, since it occupied a prominent position on the refrigerator, a first-class painting job was required.

From observation of the operation, it was apparent that the operator was wasting paint because, as he moved his gun back and forth, he invariably went past the end of the object being sprayed, and, during the time he was changing the direction of his movement, the paint was missing the refrigerator entirely since the operator did not shut off the gun as he came to the end of the surface being painted. As we have already seen, the time for stopping the hand and changing direction is a substantial part of the cycle. Thus, the operator was not only wasting time but paint as well. An analysis of motion pictures taken of this operation showed that during 23 per cent of the time the spray gun was in use, the paint was not hitting the surface of the unit being sprayed but was being wasted.

By careful training of the operator and some changes in the workplace, including a power-driven foot-controlled turntable for the work and three fixed spray guns mounted above the turntable in addition to that used by the operator, the following results were obtained: (*a*) Savings in time, 50.6 per cent; (*b*) reduction in rejects, 60 per cent; (*c*) direct labor savings per year, \$3750; and (*d*) savings in paint per year, \$5940; at (*e*) cost to develop and install new method, \$1040. Not only did the total savings in direct labor and paint resulting from the improved method amount to a substantial sum, but the great reduction in the number of rejects was of importance also. With the old method of spraying, most of the rejects resulted from "runs" in the paint. In such cases, the excess paint had to be scraped off and the unit repainted, which was an expensive operation. The improved method eliminated most of this type of reject.

TIME FOR "GRASP"

Since all manual work consists of a combination of the 18 therbligs, fundamental information about the ease of performing them would be useful in indicating proper methods for doing all kinds of manual work. At present, a program of research work is being carried on in the motion and time study laboratory at the University of Iowa to discover such fundamental information. Results of some of our recent studies will be given.

Of the 18 therbligs, grasp is one of the most common. In studying this therblig, it is desirable to consider the transport-empty therblig that usually precedes grasp and the transport-loaded therblig that usually follows it. There are many different forms of grasp, that is, there are many ways of taking hold of an object. Two common types are, (*a*) pressure grasp or pinch, as in grasping a coin lying on a flat

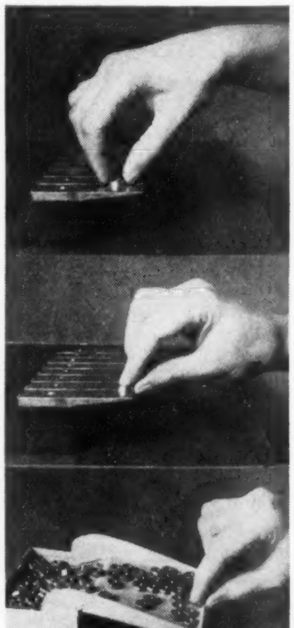

FIG. 2 EXAMPLES OF GRASP

(In order from the top downward they are, pressure or pinch grasp being used to pick up a brass washer, $^1/_8$ in. thick, on a flat surface; hook or lip grasp being used to slide a brass washer, $^1/_8$ in. thick, off the edge of a flat surface; and the same grasp being used to pick up a small nut on the lip of a bin.)

surface; and (*b*) hook grasp or lip, as in grasping a coin by sliding it off a surface or bin lip with one finger while bringing another finger up from the underside of the surface or bin lip so that as the coin leaves the bin lip it will be between the balls of the two fingers.

Brass washers, $^1/_2$ in. in diameter and varying in thickness from $^1/_{32}$ to $^1/_2$ in. were grasped from a flat surface, Fig. 2, by each of the two methods described in the preceding paragraph, carried through a distance of 5 in. and placed on a flat surface. A low-potential electric current passing through the washers and a light beam passing over them to a photoelectric cell were the means of measuring the length of each therblig in thousandths of a second. The results of one study of 10 operators are shown in Fig. 3.

These results show that, in this particular case, time for the hook grasp is shorter than for the pinch with washers $^1/_8$ in. or less in thickness. The time to carry the thin washers through a distance of 5 in. and place them on a flat surface was also less when the hook grasp was used. The pinch grasp was superior to the hook grasp for washers of a thickness greater than $^1/_8$ in.

"GRASP AND SLIDE" VERSUS "GRASP AND CARRY"

It is common knowledge that grasping and sliding small objects, such as washers or nuts, is preferable to grasping and carrying them, but few people realize that the grasp may be 20 or 30 times longer when the object must be picked up and carried than when it is moved by sliding. A $^3/_8 \times$ 1-in., bolt with

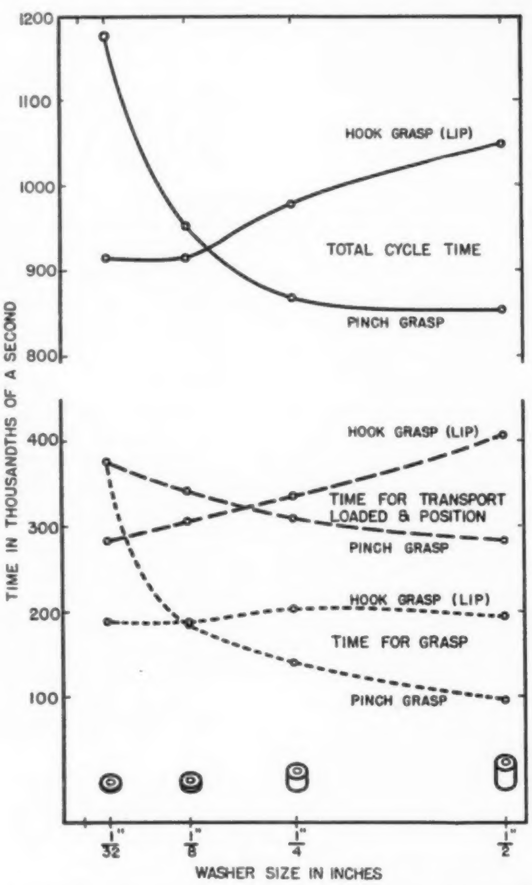

FIG. 3 CURVES SHOWING THE EFFECT OF THICKNESS OF WASHERS ON TOTAL CYCLE TIME, TIME FOR GRASP, AND TIME FOR TRANSPORT LOADED AND POSITION WHEN A HOOK OR LIP AND PRESSURE GRASPS WERE USED

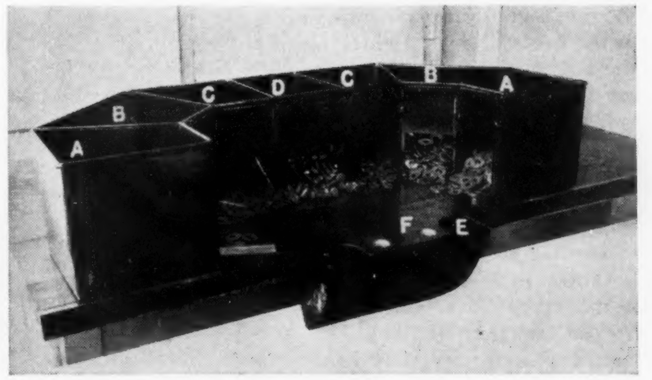

FIG. 4 BINS, FIXTURE, AND CHUTE FOR BOLT AND WASHER ASSEMBLY

(The letters designating the various parts are as follows: *A*, bin for rubber washers; *B*, bin for steel washers; *C*, bin for lock washers; *D*, bin for bolts; *E*, top of metal chute through which assembled bolts and washers are dropped into tote box; and *F*, countersunk holes in which assembling is done.)

lock, plain steel, and special rubber washers is used in the final assembly of a refrigerator. The operation was facilitated by having the three washers previously assembled on the bolt. Consequently, this was done by girl operators at benches in another department.

The first method used was to have the operator hold the bolt in her left hand and assemble the washers on the bolt with her right hand. Because of the excessive amount of holding required of the left hand, a new method of assembly was devised. To enable both the right hand and the left hand to work simultaneously in assembling the bolt and washers, a wood fixture was constructed as shown in Fig. 4. Two countersunk holes were made in the edge of the fixture so that the washers could be slid from duplicate bins into holes, the rubber washer on the bottom, the steel washer next, and the lock washer next. The bolts were then inserted through the washers which were lined up with the holes concentric. Since the diameter of the hole in the rubber washer was smaller than the outside diameter of the bolt, the rubber washer gripped the bolt and permitted it to be withdrawn with the three washers and dropped into the top of the chute which leads to a tote box under the bench.

It is apparent that, using the fixture and bins shown, each washer could be grasped and slid into the countersunk hole in the fixture. However, if a partition were placed in front of the bins the operator would have to grasp the washers and carry them to the holes in the fixture. To determine how this change to grasp and carry would affect the time for the operation, such a partition, $^1/_2$ in. high, was placed in front of the bins and, by micromotion studies, data were taken of the time for the various therbligs. Table 2 shows the difference in the

TABLE 2 TIME REQUIRED TO GRASP AND TO GRASP AND TRANSPORT VARIOUS SMALL WASHERS

	Time, min			
	Grasp precedes		Grasp plus transport by	
	Carry	Slide	Carry	Slide
Rubber washer.......	0.00960	0.00033	0.01650	0.00673
Steel washer.........	0.00895	0.00031	0.01425	0.00927
Lock washer.........	0.00750	0.00038	0.01605	0.00749

time for grasp in each case and the combined time for grasp and carry and grasp and slide. These data show that, in this case, it requires approximately twice as long to grasp and carry the washers as it does to grasp and slide them. The arrangement shown in Fig. 4 for assembling the bolt and three washers saved

53 per cent over the original method of placing washers on the bolt one at a time by grasping and carrying.

GAGING HARD-RUBBER WASHERS

Another application of the principle that a "grasp and slide" is definitely faster and easier than a "grasp and carry" is shown in Fig. 5. The gage in this operation was developed by the American Hard Rubber Company for inspecting hard-rubber washers and rejecting all that are too thick or too thin as well as those having burrs on the edges. The washers have the following dimensions: Outside diameter, 0.280 ± 0.002 in.; inside diameter, 0.188 ± 0.002 in.; and thickness, 0.085 ± 0.005 in.

The metal bar *A* forms a go gage and the bar *B* a no-go gage with the base *C*, which is a heavy metal plate set at an angle with the bench top. Washers to be inspected are drawn from the hopper *D* by hand into the upper section of the inclined go gage. Those washers that do not slide underneath the bar *A* are too thick and are slid in multiple to the chute *E* at the left of the gage. Pieces that go through the gage *A* drop down into the middle compartment. If they are too small, they slide under the gage *B* and drop into the box *F* directly in front of the operator. Washers that are the correct size are slid off into the chute *G* at the right.

FIG. 5 SPECIAL GAGE FOR INSPECTING HARD-RUBBER WASHERS FOR THICKNESS

(*A* is the go gage; *B*, the no-go gage; *C*, base plate; *D*, supply of washers; *E*, oversize washers; *F*, undersize washers; and *G*, good washers.)

All movements of the washers in this operation are sliding transports. The washers are not picked up at any place in the cycle. They are not handled individually but are shuffled back and forth in groups across the metal plate and against the bar gages so that gravity is able to act as the force which tends to pull them through the gage. The height and angle at which the gage is mounted above the bench are such as to make the task as easy and comfortable as possible. With this arrangement, one operator inspects 30,000 washers per day.

INSPECTION OF METAL SPOOLS

In the visual inspection of small parts, the procedure followed is often the same in many industries. The operator grasps the part to be inspected, moves it to a central position often directly under an artificial light source, looks for defects, and then carries or tosses the part into a tote box at the back or side of the workbench. If the part is defective, it is placed in any one of several boxes similarly located and reserved for particular classes of defects.

Often, the boxes are located at a considerable distance from the operator, thus requiring a longer time for the transport-empty therblig than is necessary. Studies show that it may take from 25 to 50 per cent longer time to move the hand through a distance of 24 in. than through 8 or 10 in. Moreover, in many cases the workplace is arranged so that the operator is compelled to dispose of parts into boxes or bins at such a great distance that he must draw back his hand and throw the piece. This may even involve deciding into which one of several bins the particular kind of defect is to go and then aiming before throwing.

Although a number of principles of motion economy were employed in working out the improved method of inspecting metal spools, this new method does make use of transports and releases that are shorter and easier than those used in the old method. The operation is that of inspecting special metal bobbins or spools for dents, scratches, heavy paint, light paint, and bent flanges. By the original method of inspection the inspector, seated at a table with a lighting unit hanging directly above the table, picked up one spool from the pile on the table with the thumb and index finger of each hand and inspected it under the light. Good spools were placed in order in a tray at the right-hand side of the table.

Since 25 inspectors were required to do the work in this department, a careful study of the inspection method was made, using the micromotion technique. As a result, a new table was designed, which cost less than $25 each. The improved method of inspection now used differs from the old in several ways.

Two lights on the new table furnish illumination for inspection. One is located on the front edge of the table and the other is located above and toward the back, so that it is only necessary to turn the spools 60 deg to inspect both ends. In the old method, using but one light, it was necessary to turn the spools end for end or 180 deg. Intensity of illumination was greatly increased so that 150 ft-c is now provided at the point of inspection. The bulbs are completely shielded to prevent glare.

The work of the two hands has been arranged so that the idle time of either one during the cycle is practically nil. The supply of spools is placed in a hopper by the supply man and they are fed by gravity to the inspection table. This saves the time of lifting the spools from the tote box to the table as required in the old method.

Rejected spools are dropped in openings located conveniently near the working position of the hands. In the old method, the inspector had to toss the spools into trays piled in front of her. This required more time and more physical effort than the new method. In the old method, six different bins were used for the different classes of defective spool. A study showed that only four different classes or kinds of reject were really needed, and, consequently, only four openings were placed in the end of the new worktable for receiving defective spools.

The tray for receiving good spools is located at the proper

height and is tipped up at a convenient angle. It rests on a metal track and may be easily shoved to the back of the table from which the supply man removes it. The inspector is not required to lift full trays of work.

Inspectors are now given a 5-min rest period at the end of each hour, and they are enthusiastic about it. Formerly, one 5-min rest period was provided in the morning and one in the afternoon. They are paid at their regular hourly base rate for the rest periods. For the remainder of the day, they are paid a wage incentive in the form of a 100 per cent premium for all production above standard.

Arm rests on the front of the table tend to steady the hands and reduce fatigue. Chairs are carefully adjusted to fit the individual inspectors, who can now inspect twice as many spools per day as formerly, and they apparently do it with less eyestrain and fatigue. Less than one half the floor space is required for the inspection work, and the department has a neater appearance than formerly. Quality of inspection has not suffered by the increased output per inspector.

POSITIONING PINS AND STEEL BARS

Since much assembly work, gaging operations, and benchwork consists of picking up materials or tools, carrying them to a jig, fixture, or gage and positioning them, a series of studies[3] dealing with the therblig position will be considered. The first investigation deals with the time required to position pins $^1/_2$ in. in diameter and $1^1/_4$ in. long, in bushings with beveled holes when the amount of bevel surrounding the hole in the bushing varies from 45 to 0 deg.

Two cases were considered; (*a*) when only a small clearance, 0.002 in., was provided between the pin and the hole, which is analogous to a go gage for small pins, shafts, and similar parts; and (*b*) when the clearance was considerable, 0.010 in., which is analogous to the assembly of pins, bolts, screws, and the like in holes. A light beam falling on a photoelectric cell and carefully balanced mercury switches were used to measure the length of the therblig position and the therblig transport loaded, time to carry the pin from a magazine containing the supply of pins to the bushing and begin to insert it in the hole in the bushing. Time was recorded in thousandths of a second. Fig. 6 summarizes the most important results of this study.

A companion study to the one just described is that of determining the effect of changing the shape of the top of two steel pins on which $^1/_8 \times {}^5/_8$-in. cold-rolled steel bars, 3 in. long, with two $^1/_4$-in. drilled and reamed holes, spaced 2 in. on centers, were assembled. This study was made where (*a*) only a small clearance, 0.003 in., was provided between the pin and the hole, which was analogous to a go gage or to fairly accurate assembly work; and (*b*) the clearance was considerable, 0.011 in., which was analogous to rough assembly work.

Five different "pin sets" are shown in the lower part of Fig. 7. From left to right, these are with guide at left-hand end and back of the pins, smooth pins with square ends and of equal height, smooth pins with square ends and of unequal height, smooth pins with round ends and of equal height, and threaded pins with square ends and of equal height.

A light beam falling on a photoelectric cell and carefully balanced mercury switches were used to measure the therblig transport loaded, and the therblig position i. e., time to carry the bar from the supply to the "pin set and place on pins." Time was recorded in thousandths of a second. Fig. 7 summarizes the important results of this study.

Although it is true that our present knowledge of the elements of motion economy is not being fully utilized, it is evident to all those working in this field that much more information of a basic nature is badly needed. The fact that many of our machine tools, as well as mechanical products, are inconvenient to operate would seem to indicate that those who design and manufacture them are primarily concerned with the mechanical functions that such apparatus is to perform and give too little thought to the way the machine will be operated.

Some companies are

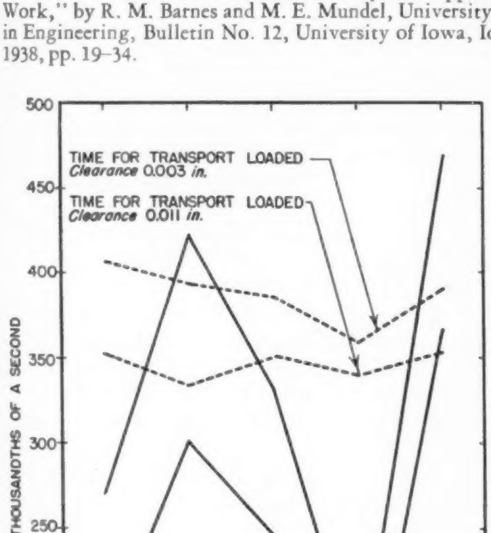

Fig. 6 Curves showing the time to position pins in steel bushings and for transport loaded when the clearances were 0.002 and 0.010 in.

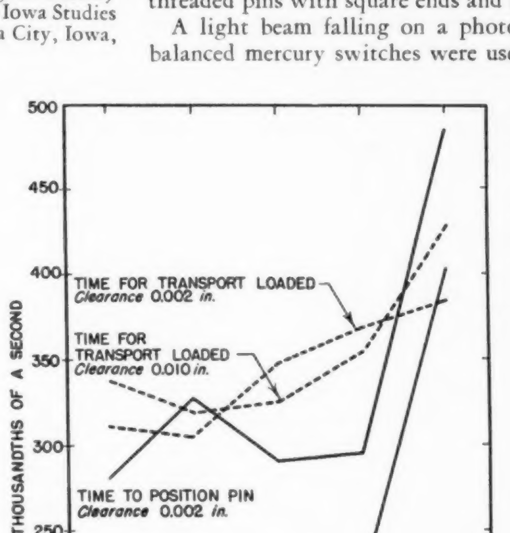

Fig. 7 Curves showing the time to position bars on "pin sets" and for transport loaded with clearances of 0.003 and 0.011 in.

[3] "Studies of Hand Motions and Rhythm Appearing in Factory Work," by R. M. Barnes and M. E. Mundel, University of Iowa Studies in Engineering, Bulletin No. 12, University of Iowa, Iowa City, Iowa, 1938, pp. 19–34.

now conducting studies to find basic information bearing on the proper design of machine elements in relation to the operator, and I believe that, in the near future, we shall see much more of this. Such research will not only result in better designed production equipment but will also lead to the design of products for general use which will be easier to operate. Therefore, labor, management, and consumer all stand to gain from any research that points the way to more effective utilization of human effort. In this paper, no attempt has been made to review the findings of the many researches bearing on the problem of motion economy, but rather it has been the purpose to cite some recent investigations that we have conducted and to show a few typical examples of the practical application of these findings.

Acknowledgmect is made to Marvin E. Mundel, research assistant in mechanical engineering at the University of Iowa, who carried on the studies using the photoelectric-cell technique referred to previously.

UNPARDONABLE INTERRUPTIONS

The Incompetent Chairman and the Bungling Committee

By S. MARION TUCKER

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THE LARGE and intelligent audience that assembled to hear Williams' speech on "Some Implications of the Quantum Theory," in the large auditorium at 10:30 a.m., will not soon forget what happened nor will it soon forgive that inept chairman for permitting those wholly superfluous and monstrously disturbing interruptions on the platform which not only broke the flow of an excellent address but also seriously annoyed every person who was trying to listen to it.

Nor will Williams soon forget—or forgive. For all those interruptions were due not to the speaker or the audience but wholly to lack of considerateness on the part of the chairman, or of the committee on arrangements, or perhaps of both combined.

Other speeches were, of course, to follow Williams', in that same auditorium, with scarcely a moment's intermission, such was the exigency of the rich and extensive program. The chairman, to be sure, was a busy man that day and had many things on his mind. He was responsible, as it happened, not only for the seemly conducting of that particular speech but also for the several to follow it. And something had gone wrong. Hence, not once but several times, as he sat on the platform, ostensibly listening to Williams' speech but really with his harassed ear to the ground, he was greeted by a messenger who strode onto the platform and whispered things into his ear—the one on the ground. The whispered conversation, although not audible, was unpleasingly visible, and both Williams and his audience were painfully conscious of it. Action was taking place on that platform, but action utterly extraneous to the speaker's business. During those moments of hurried converse, Williams faded out of the picture or at least became only a secondary figure. What, one inevitably wondered, had gone wrong? What was this whispered conference about?

But Williams, fortunately, was quite equal to the occasion. This was not the first time that he had suffered from such untimely and untoward interruptions, and he had acquired a technique, polite but devastating. He simply stood quiet and silent until the whispering was over, then he again took up his speech. The chairman was confused by this unexpected though quite justified maneuver, but the audience with a smile, either inner or outer, noted it with entire approval. This happened three times in the course of a half-hour speech.

But this was not all, by any means. Ten minutes before the end of Williams' speech, two noisy attendants strode onto the platform and began to arrange the exhibit that was to be used by the next speaker. They moved about considerably and made quite a diverting picture. This, of course, was far worse than even the whispered talk between the chairman and the messengers. Now, those minutes belonged strictly to Williams, not to the succeeding speaker. But deliberately, with the admirable firmness born of experience and characteristic of a hero who sacrifices himself for a worthy principle, he gave up three of the minutes while he again stood silently and quietly until those demonstrative attendants had finished arranging their exhibit.

But whether it's a whispered conversation between chairman and messenger, or one between persons on the platform other than the speaker, or the placing of exhibits, or the hanging of charts or of a picture screen, it's all the same kind of interruption, all equally upsetting to the speaker and annoying to the audience, and all equally uncalled-for and certainly unpardonable.

From such experiences, Williams has formed some strong and unflattering opinions about inconsiderate and delinquent chairmen and committees on arrangements and has recently organized a group known as the "Association for Speakers' Rights to Decent and Humane Treatment." The Association has formulated certain ironclad rules which, as a labor union, it proposes to have adopted by all societies, formal or informal, temporary or permanent, which essay to present speakers under their auspices:

(1) No untoward interruptions, due to neither speaker nor audience, shall be permitted during the course of any speech, such as messages to a chairman on the platform or whispered conversations between persons on the platform other than the speaker. If the speaker has any reason to expect messages, *he shall not sit on the platform during the course of a speech.*

(2) Exhibits, charts, or any material whatsoever, needed by the succeeding speaker, shall be placed in readiness near the platform, in the rear of the platform, or in some convenient nearby spot, and shall actually be placed where it is to be used only after the speech of the preceding speaker has been entirely concluded.

(3) Any speaker who finds himself subjected to untoward interruptions, due solely to carelessness or lack of considerateness on the part of "the management," shall cease speaking entirely while such interruptions are in progress and shall make it plain by his attitude, though of course quietly and politely, that he actively resents such interruptions, both for himself and his audience.

Relationship Between
MANAGEMENT *and* EMPLOYEES

By C. R. DOOLEY

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IN SPITE of general complaining against present-day conditions, the fact remains that the great majority of business men have shown a changed attitude toward their employees and the public in the last few years, so that most of what I have to say tonight will not be new to you. Some 20 years ago, Gano Dunn, then president of the American Institute of Electrical Engineers, defined engineering as a "method of thinking." This implied careful analysis and orderly procedure through logical processes to a rational conclusion. This was good in its day. Today, the manager's thinking must be more than logical; it must be psychological. His processes may be perfectly right, but, if they are not understood and accepted by his employees and geared to long range rather than short range, he will have difficulties.

We used to hear it said that, if management provides a good fat pay envelope, other things do not matter. I doubt if this were ever really true, and we are getting farther and farther away from that line of reasoning. If this premise had been true, employee relations would never have developed as they have over the last 30 years. Men work for pay because they must have money to pay their bills, but, in their own minds, other things are more important, and these things constitute the relationship between management and employees with which we are seriously concerned. This, like all satisfactory relationships in the world, is built on cooperation and understanding, reaching toward a common purpose.

PRESENT POLICY IS ONE OF COOPERATION

In the past, two traditional methods have been followed in dealing with employees; one of complete arbitrary rule and the other of paternalistic care. We have had instances of both in the United States, and some still remain. These methods presuppose two viewpoints, one of management and the other of employees. Today, the policy is more one of cooperation between management and employees with mutual understanding, confidence, and respect. The time has gone when management could shut itself up in its office, formulate plans, and then present them to the employees as final. Employees are no longer to be considered as so many "hands" to do the bidding of a supervisor, but as thinking men whose cooperation is essential to make any plan of operation work. No matter how good a plan may look on paper, it will not work unless it has the wholehearted support of the employees, or better still, if the employees have helped to formulate it. Successful management recognizes that no plan works well until it is thoroughly understood by the employees.

The level of education and understanding on the part of any large group of plant employees is rising. First, the depression has brought the subject of economics home to a larger number of people than ever before. The frequency with which this subject has been discussed in the press has tended to influence all manner of people to try to understand the economic reasons for the depression, whereas, during previous depressions, they were rather content to take their misfortunes as inevitable, put their trust in Providence, and wait patiently though blindly for the tide to turn. Second, young men entering plants today are better educated than their fathers were when they were boys. As a matter of fact, a high-school boy can make good, earn more money, and see more ahead of him today by entering a factory than an office. This was not true 20 years ago.

Employers today should not be paternalistic but rather should provide a common-sense method of securing consideration and justice for each individual employee and stimulating his personal ambition and sense of belonging to a great company. Above all, they should give employees a clear understanding of the objectives of the company and their place in the program. Employees do not want to be treated like children, but as adults with a capacity to understand their work, and to assist with their brains as well as their hands. They want to be heard.

SUPERVISORY FORCE MUST BE INSTRUCTED IN COMPANY'S POLICY

A word should be said here concerning the supervisory force. Management may sincerely adopt a sound program, and the employees may have a cooperative attitude, but each is constantly being interpreted to the other by the supervisory force, and the opportunities for misunderstanding are almost infinite. The position of even the most conscientious supervisor is often difficult. He must learn to listen and to get the facts before making decisions and to analyze situations. Therefore, it is important to train the supervisory personnel almost continuously in the policies and attitudes of the company and in sound methods of personnel management, stressing the fact that successful operation depends far more on teamwork than on star performers. This will help insure an adequate supply of young executive material, efficient yet considerate, courageous yet cooperative. To define this relationship a little more concretely in brief, employees want first of all just and competent leadership, a clear understanding of company policies and objectives and what their respective responsibilities and authorities are, opportunity to contribute ideas as well as work, and an honest appraisal of their service. Employers expect an honest day's work, intelligent application not only of the employee's time but interest in the job, a sincere interest in his company outside of the job, ambition to prepare for promotion, and an unrestrained will to cooperate.

Neither management nor employees need prate about loyalty to each other, but both expect loyalty to their business ideals and traditions, each striving to do what is right rather than what is expedient. Along these lines, more is really expected of management because of its training, experience, and position of leadership. Business today is a social as well as an economic organism. By social, I do not mean merely a social obligation to the community or even to the nation as a whole, but in addition to these, a recognition of the fact that employees

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of any given plant form themselves into social groups which, if recognized and cooperated with, produce greater efficiency than if ignored by the management in the process of promoting technical efficiency.

We all realize that the relationship between employer and employee is not a new idea—it is as old as the first employer and his one or two employees, but, with the growing complexity of industrial organization and the impossibility of management dealing directly with each employee, it has become necessary to set up some definite program, which in many companies today has developed into an extensive industrial-relations policy. A good industrial-relations program is a means of education for both management and employees. Each one learns to see both sides of a question. The ideal employer-employee relationship presupposes understanding of the problems of each group, not as separate and distinct, but as interrelated.

The modern industrial-relations policy of a company is a vital part of its management program and not merely an inspection service. It is just as vital as the handling of finance, markets, prices, competition, purchasing, construction, manufacturing processes, or any of the other basic factors. In fact, human relations run through all phases of business and industry, and, if they are not managed wisely, the management of the whole company is inefficient and unsatisfactory. Good industrial relations, in short, is the basis of all good management. Each company officer, manager, department head, and supervisor is, whether he knows it or not, responsible for his company's industrial relations.

Basic factors of the industrial-relations policy should be written down and published to all employees. This insures backing by the managers and cooperation by the supervisors. It inspires the confidence of the employees in the management. The example set by management is a great power for either good or evil. Effectiveness of industrial relations emanates from top management in its attitude toward the representatives of employees. The following quotations are taken from the preambles of the published industrial-relations policies of two different nation-wide companies:

> The Company is now and for some years past has been committed to a policy of cooperation with its employees in all matters of mutual interest, confident that thereby the best interests of all are served, and only in this way can the many benefits which all now enjoy be perpetuated.
>
> The purpose of this statement is to make clear to the entire personnel of ...... Corporation — employees, supervisors, department heads and operating executives — the principles for which the general management stands and which it intends to make increasingly effective in the conduct of human relations throughout the Corporation. It is designed to improve mutual understanding and respect and cooperation.

To put the foregoing philosophy into effect means the establishment of a well-rounded industrial-relations program involving a number of specific items that fall into two categories—those which are intimately personal between employees and management, such as collective dealing, handling grievances, policy on wages, and hours and conditions of work; and those which are highly technical, such as insurance plans.

WHAT EMPLOYEES EXPECT FROM MANAGEMENT

Time will not permit me to outline a complete industrial-relations program, but I would like to discuss a few of the items previously mentioned which employees expect from management. They expect management to have a definite organization, to assign definite responsibilities to each position with corresponding authority, and to pay salaries and wages commensurate with responsibilities. The basis of these things is an impersonal job analysis, evaluating each position in terms of others in the company and the establishment of definite lines of authority. A policy of salary administration should be based on salaries and wages paid by other companies for similar work in the community and upon the maintenance of logical differentials between jobs of different classes, with, of course, attention given to the cost of living and the company's ability to pay. This takes care of the situation logically, but, psychologically, more ramifications exist, which bring the employee-management relationship directly down to the supervisor or department head. Up to this time, the question has been more or less the greatest good for the greatest number. Now, it becomes a psychological problem of dealing with individual employees. This is the last step from management to employee and also the first step from employee to management. It involves the adjustment of the man to his job and his department and to the company. It is not so much a matter of providing "pills," or hot and cold water, or even adequate pay, although these must be attended to, as it is a complete understanding of the attitudes of the employees and respect for their personalities and status in the organization.

Employees tend to adjust themselves into local social groups which are exceedingly sensitive, and management should understand this. For example, desks are not just table tops and drawers with which to work but symbols of status, and their rearrangement alone may disturb the local daily social routine and upset completely the efficiency of an office. The reactions brought about through misunderstandings, fear, and special favors are far greater than any of us realize. Recently, I talked with a former captain in the British army who said that, in his experience, soldiers suffered far more from fear of undercurrents, discrimination, jealousy, intrigue, and misunderstanding within their own ranks, including their officers, than from the fear of shellfire. It is a terrible thing when the self-confidence of any man drops to such a point that his whole life is filled with fear. The general concensus of opinion is that these nervous strains contribute directly to serious physical ailments. Here again, the relationship between management and employees can be materially improved by establishing an adequate medical service, providing medical examinations, first aid, adequate diagnosis, and general medical counsel. While this service primarily is to guard against ill-health and accident hazards, much other helpful understanding results. Industry, by and large, has not scratched the surface in the matter of medical and health service in finding the causes of mental, physical, and psychological maladjustments. Management must be sensitive to these things but should approach them from a practical and psychological point of view—neither paternalistic on one hand nor hard-boiled on the other.

BOTH MANAGEMENT AND EMPLOYEES PROFIT

When the boss and his men are mutually adjusted, an employee will give his boss the benefit of his ideas and criticism without fear of losing his status or having his ideas stolen, and managers will learn and prosper thereby far more than if they repressed such comments under any false notion of preserving their own dignities.

The late E. K. Hall used to refer to employee representation as a two-way track, from employees to management and from management back to employees. We may carry this line of thought still farther and think of the relationship between management and employees as a round table, over which ideas may shuttle in any direction. Where there is respect for personalities, freedom of discussion, and loyalty to the business before personal interest, there cease to be two contending factions.

(*Continued on page 408*)

New EMPHASIS *in* MANAGEMENT

By LILLIAN M. GILBRETH

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THE NEW emphasis in management is undoubtedly on the human element. Problems of industrial relations that we have faced these last years would have made this inevitable, even if the trend had not been that way, which, as a matter of fact, it was. If one goes over the history of scientific management, with an appraising eye and as an historian of the future might go over it, he sees that from the start an emphasis that was new was laid on the human element. The first industrial revolution was characterized by the coming of the machine. Housing, utilizing, and conserving the machine was the engineers' chief problem. Variables of the machine, its surroundings, equipment and tools, and the methods of using it were questions of prime importance. The worker was the "hand" involved in the operating.

We may well call the coming of scientific management the second industrial revolution, although, of course, we hope it may be evaluated as an evolution. Scientific management shifted the emphasis to the worker, the man involved in the work process, and concerned itself with the variables that concerned him, his surroundings, equipment and tools, and the methods he used. It insisted that engineering technics of measurement, and finding and facing facts be retained, thus attempting to use the disciplines of exact science in a field that had been left largely to those accustomed to using less severe technics.

This did not preclude a humanitarian view of the work problems that is not always recognized in the work of the pioneers. Superficial reading of the early classics of scientific management might not make this clear, but, if one studies them as they deserve, he finds that beneath technical terminology and factory or construction problems lies concern with the men and women who do the work. "How long does it take to do work?", "What is the best way to do the work?", "How can one make it possible to get more done with no extra expenditure of time and energy?", "What is the fairest system of pay?", "How can one make costs reflect useful activity and waste to guide method improvement and increase pay?" These questions can be interpreted as means of finding out how to save money or to produce more goods and thus make money, but they can equally well be interpreted to indicate practical efforts to conserve and use human power, for the benefit of the worker, the employer, and, ultimately, society at large.

The lives of the leaders in scientific management, their own interpretation of what they did and wrote, why they did it, and the careful evaluation of students in this field all concur to show that concern with the human element was the important interest in the scientific management group. This meant that the materials, tools, and machines which had always been of great interest to engineers and industrialists of all types now took their place as adjuncts to the worker on the job. All did not go so far as to call them "extensions of the personality" of the man, but undoubtedly that was the idea which was in the minds of many.

Developments in management, through the years, as reflected by the literature, and checked by the experience of those who have been a part of this work since the start, show that the early conviction as to the importance of the human element spread, and grew more specific as well as wide. We can profitably reread Towne's "The Engineer as Economist" and the writings of Gantt, Clark, Alford, and Flanders, which follow this line of thinking; the writings of Taylor and his followers, in research and the principles and practices of management; those of Frank Gilbreth, Mogenson, Porter, and Barnes, as they outline the science of work and the technics of measurement and Emerson's philosophic thinking, as it has continued in both technical and nontechnical books, to note for oneself the progress made in stating concretely and in detail how one can enable the human element to express itself in work and to serve itself for leisure.

ENGINEERS HANDLE MEN AS WELL AS MATERIALS

In this country, engineers have had the chief responsibility for handling men, as well as handling materials, machines, and similar factors in industry. This is not true in all other countries. In England, for example, the industrial psychologist has done much of such work, especially as it covers research in the plants and out. The rigid disciplines of the engineer's training and his reliance on the technics of exact science may have made him slow to use the findings of the social sciences. But he has not failed to use the most exact measurement devices available or to make it clear that he is handicapped by the lack of fundamental research as yet undone, which requires physiologists, psychologists, and engineers, working in industrial situations.

The engineer is helped in this work by the fact that he operates within a field of activity and accepts a framework of thinking which insures that what he does shall be constructive and not destructive. As a group and as individuals, engineers hold a philosophy that is positive and usually optimistic. They believe that life is worth living and handing on, and that it is worth while to be active, to work, to make things, and to enjoy them. They reflect the teachings of the philosophers who hold such views, starting with the Greeks and tracing through. They follow the teachings of an occidental system, which is individualistic in its sense of responsibility but which has as its ideal the service of each for the good of all. Through the years, they have followed their own great leaders—Leonardo da Vinci, James Watt, and Thomas Edison—who exemplified creative power, belief in its value, and use of what they had.

The engineer has not always submitted to the disciplines of learning and using formal logic, but he has submitted willingly to the discipline of facts, searching for them, facing them, and using them as best he could. He has refused to believe that things were so because he wanted them to be so. He can take pride in not having set up a desired conclusion and then gone out to try to find the facts to prove it. He has sometimes limited the scope of his thinking by refusing to go beyond his facts, but he has not fallen into the error of wasting a large amount of time and energy gathering what pretended to be facts, because of bringing to the job preconceived notions as to what he would find. It is thinkable that some of the conflict between the exact sciences, which he represents, and the social sciences, which often scorn his work, has arisen because of his belief that only facts collected with an open mind are really facts. This

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background of belief is what he brings to the reading of such provocative writing as Hogben's "Retreat From Reason." He may have many faults, but he will *not* retreat from facts.

The engineer has been fortunate in that his personal ethics have been fortified by the rigid code of ethics of his profession. This code acts as a guide to making decisions as well as a help in maintaining them. The management group subscribes to this code, of course, and is fortunate also that its work makes it necessary to think in terms of the square deal to every one. Management is only as good as it is fair. In the early days of scientific management, it was thought that danger might arise that the findings of the new work, and especially the methods and devices by which it was done, might be available to people whose ethical standards were low, and might thus be used to hurt people. "Spying time study," "speeding up work beyond the factor of safety for the human element," and "excess physical and nervous fatigue," were all fears which were held that the new means of getting work done would be wrong uses. But they were groundless, for the only time study that is useful is the one in which the worker participates; speeding up is a matter of machines and not of men, except as it involves the selection and training of workers who profit by and like the higher speed. Overfatigue affects the quality and quantity of work so quickly and so adversely that it or the things that cause it are soon discarded, if the new emphasis on the human element does not prevent it.

INDUSTRIAL APPLICATION OF AESTHETICS

Aesthetics is not usually rated as a part of the engineer's training, and perhaps it is true that beauty usually comes into the workroom rather as a means of eliminating fatigue and conserving health than as ministering to the feeling for the beautiful. Yet love of fine workmanship and pride in possessing the skill that results in a perfect thing is surely an important element in appreciation of the beautiful. It is interesting that all three branches of methods work contribute increasingly in this field. Fatigue study eliminates ugly sights and sounds and introduces beautiful ones. Diffused light; reduced glare; attractive colors; elimination of distracting rhythms, loud and raucous noises, and the like and the introduction of rhythm, harmony, even melody, where that is appropriate, all these are of aesthetic value. Motion study sets up standards that are satisfying to the type of worker selected for the job and work methods that have been checked for contentment factors as well as efficiency. Aesthetic factors are definitely a part of many satisfactions that lead to contentment on the job. A listing of the 21 elemental sources of satisfaction, so far discovered, goes to show this. These are (1) quantity, (2) quality, (3) variety, (4) kind of finished product, (5) speed, (6) power, (7) rhythm, (8) physical activity, (9) personal skill, (10) exercise of skill, (11) hours, (12) bonus, (13) wages, (14) security, (15) chances of advancement, (16) mark of personality, (17) position of firm, (18) position in firm, (19) working conditions, (20) social facilities, and (21) type of fellow workers. Of these (2), (4), (7), (19), and (21) would seem to have definite aesthetic significance; (10), (16), and (17) probably have; others might have.

Motion study also stresses careful selection of the worker for the job, by physical, mental, emotional, and social tests, so that he may find the standards satisfying. It provides flexibility enough to modify the standards, by allowances in setting the task for the individual, if that is necessary. Study of the best types of job analysis show that we are improving constantly in knowing what is wanted on a job, and similar careful studies of personality analyses show that we are coming to know more and more of what people can do and what they like to do. Books like Mrs. Shepard's "Human Nature at Work" stress the importance of such information.

Skill study, in its eighteen criteria for judging and grading the skill of the man on the job, includes degrees of precision of motions and degree of speed of reaction to sense stimuli, both of which have aesthetic implications. It also stresses patterns of dexterity that are rhythmic and proves that grace, rhythm, balance, and form are fundamental to all skilled performances.

Such pioneer thinking in the field of aesthetics as applied to industry as was done by the late Calvin W. Rice, distinguished secretary of The American Society of Mechanical Engineers for many years, is beginning to show results. He believed that as many people as possible should be allowed to work on beautiful things; that all workers should be helped to see the beautiful in their work, the product, or the method; and that work should be done in as beautiful work surroundings as possible. Where these ideas have been followed, the results have been good not only in increasing satisfaction, but also in more and better production.

The economic thinking of the engineer has not always been dignified by that name, as the engineer has been modest about calling his ideas by such a formal title. Yet he has firmly believed, through swings in popular thinking, in the "economy of plenty." He has, of course, been disturbed to be accused of having caused or increased the depression, by making more things than the consumer could apparently use. In some cases, he has been troubled for fear that he might have made conditions worse by inventing machines to make things and possibly putting people out of work. But clear thinking soon showed him that not more things than the consumer can use were produced, only more than he can buy. Too many things cannot be produced until every one has all that he needs, if not all that he wants. What is wrong is lack of consumer purchasing power. And careful unemployment studies go to show that, in the long run, new machines bring new jobs, and, even in the short run, other more dangerous causes of unemployment are tied up with lacks in the human element, than are involved in machines and improvements in technology.

LOWERING PRICES AND RAISING WAGES

The engineer is too experienced to believe that lowering prices is useful, if wages are lowered as fast or faster than the prices, or that raising prices will be useful if wages are not raised faster or higher than prices. He knows from grueling experience that wages can only go up safely through lower costs and higher selling prices or efficiency that makes savings. He knows too that wages must be thought through in relation to what they buy, in the necessities of life—shelter, food and clothing—and in the luxuries that make life interesting. He realizes too, from long experience, that "as the incentive, so in the long run are the results also," and he continues to test financial and nonfinancial incentives with great care. He has not often had the booklearning in economic theory that men in some other walks of life have, but he has the experience that leads to the necessity of formulating theories and the temperament that forces him to test them thoroughly. He does sound thinking on capital-labor situations, because of his firsthand experience with the factors involved in running an enterprise. His thinking is perhaps best exemplified by the wise and most understanding leader in his field, Herbert Hoover, who combines the soundest of theories with the most wide and useful practice in engineering and in citizenship.

From its beginnings, scientific management has emphasized the importance of keeping costs. Not the use of an elaborate

cost system, which is the pride of its inventors and of its users because of its complexity, "so wonderful that not one of us really understands it," but a simple means of knowing what things cost and what one can expect them to cost. We remember that F. W. Taylor protested against the cost systems that he found in most plants where he worked and insisted that costs must be handled by an engineer or at least by the engineering method. This means that the system must have no dump alls, fuzzy overhead, or miscellaneous but must provide itemized records of every cent spent, in such shape that they could be used as material for preparing plans and budgets. This was essential if the management engineer was to know where he was going and to have justification for his projects. If he wanted new materials, machines, or men, he must be able to know what the ones he had cost, how much the new ones would cost, how long it would take to pay for the added costs through the savings that they had made possible, and the life of the purchase after the cost had been paid for. Just as he found that, if he wanted usable statistics for his work, he must be prepared to furnish statisticians with the data on which they worked or at least to verify them, so he found that if he wanted usable costs he must furnish the data or verify them. Not because the statisticians were not honest, but because their job was to make all possible use of the facts, but not to be informed as to what the necessary facts were. It is a new emphasis here, that the realization is increasing that all activity must be translated into terms of costs, in order that the human element may get the most possible for its work.

METHODS WORK GAINING IN IMPORTANCE

Perhaps it will be useful, in trying to show that the emphasis on the human element is constantly increasing, to scrutinize carefully methods work today, as a branch of management that is gaining in importance. Industry has come to realize that waste must be eliminated and that human waste is most important. This seems self-evident, yet it was new, when scientific management started, and its almost universal acceptance is news. In many industries today, the cost of raw materials is increasing while the selling price of the finished article tends to decrease. In well-run, progressive plants it is not planned to try to meet this situation directly by lowering wages, or by such indirect means as changes that allow the management to save money while the worker spends it, in energy.

The effective, right way to make the essential savings is through methods work. Here, by time and motion studies, unless the work has been recently and exhaustively checked, it is possible to make savings up to an average of 33 or even 50 per cent, with no more expenditure of time and energy. But in these days, when industrial relations are so unsettled, one dare not make this saving unless the workers are in favor of it, cooperate in it, in fact want it enough to vote for it and even ask for it. Where human relations are poor, one cannot hope that even such methods work as aims to provide the money to hold or increase wages will be welcome. It may be made the excuse for an explosion that has been long delayed and is only waiting for an outlet. The strike or upheaval may not be in a causal sequence with the plans for methods changes, but it may be in a time sequence. Once it happens, it is difficult to explain that the methods work was not the cause. It may have served a fine purpose by bringing to a head something that has been annoying for a long time, but this is not apt to be realized, and often the methods work is delayed, discarded, and even discredited, so that it has no chance, for a long time. Knowing this, most management engineers refuse to try to introduce it, unless they are sure that industrial relations are stable. Where the history of industrial relations in a plant is good, where management and men realize that each is a cooperator in a constructive and profitable activity, methods work that is going on can be continued undisturbed, through changes in the technics of the relations. It may even safely be started, for it has possibilities of improving relations under the right conditions. In the first place, it is essential for every group and member in the organization to know all that the cost data can tell. All should know the state of the profit-and-loss sheet. All should know the budget as planned and as it is carried out, with the reasons for any changes, including the condition of the market for the product. All should be able to see what savings are necessary, if personnel and wages are to be maintained. Completeness and detail help, but two lines of a chart sometimes indicate the problem. One shows the cost of the raw materials, the other the selling price of the finished product. If the first goes up, and the second goes down, what is the problem and what is the answer? This is not the complete story, of course, but it may be the first chapter, so far as getting the entire organization informed as to what the problems are.

It seems obvious that costs must be maintained, not raised, and, if possible, lowered. How can this be done, without lowering the wages that are so essential to the morale of the entire organization? It is not only to the worker morale that they are essential but to the employer morale as well. The amount made available to the human element of any industry is a measure of its competence. Would it be possible not only to maintain wages but also to raise them? Yes, perfectly possible, if the other variables that affect the situation remain constant, raw materials do not go up, the market remains constant, and it is possible to put a larger share of what is saved, after the cost of making the savings has been covered, into the wage fund. If it is possible to discover methods of doing the work more economically, in time and energy, and to teach the worker to use these, then money will be saved and available for wages. This is easily brought about, when no depression exists, that is to say when the market for the product is strong, when labor relations are peaceful, and when no impulse exists to take over the money saved and use it for other purposes. Even when a depression exists with fear of its becoming worse, work methods can be improved and human relations also, if management and men work together at using the money saved to the best advantage. Sometimes, it goes into the pay envelope of those already employed, puts on a few or more workers, or goes into a fund to help workers when unemployed. The important thing is that an agreement is reached as to what is to be done with it and everyone is satisfied.

INCREASING SKILL AND ELIMINATING FATIGUE

Do we have a similar problem when we discuss increasing skill and eliminating fatigue? This is a more difficult problem, because we cannot as yet define fatigue adequately or measure it. We know that, as far as production is concerned, it shows itself in decreased quantity of output. We know that it evidences itself in a human being less capable of the desired output.

We know more about skill. We can define it as belonging to a person possessing dexterity, knowledge, and ability to adjust to a changing situation. We can record it with the film and, more completely, with the chronocyclegraph. We know that its motion paths are smooth, rhythmic, patterned, and graceful, showing acceleration and deceleration; that its output has high quality in high quantity; that it provides its own safety and maintenance. As to its relation to fatigue, we find that the skilled worker usually accumulates less necessary fatigue than the unskilled, because he uses his body efficiently, i.e.,

(*Continued on page 408*)

The ENGINEERING GRADUATE'S FIRST YEARS *in* INDUSTRY

By FRANK L. EIDMANN

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HOW WELL satisfied are industrial executives with the young engineering graduates whom they employ? In visiting a large number of industrial plants over a period of years I have raised this question. Recently, I also sent a questionnaire on this subject to executives of sixty well-known manufacturing companies in many lines of industry, such as machine tools, locomotives, paper, steam turbines, electrical equipment, brass and copper, Diesel engines, automobiles, cameras, power-plant equipment, abrasives, steel, chemicals, watches, clocks, heating and ventilating equipment, shoe machinery, packaging machinery, drive chains, cash registers, ball bearings, instruments, typewriters, taps and dies, elevators, and special machinery, and also to public utilities, consulting engineers, and railroads. Replies were received from nearly all. In answer to this question, "How many of these young engineers turn out to be satisfactory?" the largest number of replies gave estimates of between 50 and 90 per cent. A few stated that only 10 per cent prove satisfactory, and two companies are satisfied with all of the young engineering graduates whom they hire.

How about the young engineers who do not prove satisfactory? What is wrong with them? The answers indicate almost unanimously that personal traits and attitude rather than lack of technical training or ability are responsible. The principal fault seems to be the "inability to get along with their associates," or the "lack of ability to fit in quickly with their fellow employees and to make friends readily." The criticism mentioned in the next largest number of replies is "overeagerness for advancement." Other criticisms are: "Unwillingness to prepare for advancement over a long enough period," "lack of aptitude for engineering work," "inability to adapt themselves to the routine of operating work and at the same time avoid getting into a rut," "lack of initiative," "inability to grasp the practical aspects of problems and situations," "impractical and unable to apply themselves," and "lack of willingness to work."

You would be justified in asking just what is meant by the term "unsatisfactory" as used in this paper. Some of the executives made this clear by stating that probably 70 to 90 per cent of the young men turn out to be reliable routine workers, and, so long as their work does not fall below a reasonably exacting standard, they are retained. Only a small percentage of the men, however, turn out to be satisfactory in the sense of measuring up to expectations. Industry expects that, after a reasonable period of orientation, these young engineers will accept responsibility, show initiative and enthusiasm, and make more rapid progress than young men without college training who have come up through the shop positions.

It is to be emphasized that most of the executives, with whom I conferred or who responded to my questionnaire, show a keen and sympathetic interest in young college-trained engineers and offer their comments and criticism in a friendly spirit and with the hope of being helpful. They recognize the need of these young men as recruits in their organizations and would like to employ more of them than they do at present. Although some executives have become so discouraged in their experiences with young college men that they have definitely decided not to hire them until they have had a few years of experience, with other companies, most industrial executives still believe that these young men, carefully selected, are the best source of potential leaders for the future.

WHO IS TO BLAME FOR FAILURES?

In some of my interviews with executives, I raised the question concerning the responsibility for such a large percentage of the young engineers turning out to be disappointments to their employers. I asked whether the colleges are to blame, whether the trouble lies with the young men, or whether the employers are largely responsible. As previously mentioned, industry attributes most of the difficulty to the personal traits and attitude of the young engineers. A few employers place part of the blame on the colleges. None of them have suggested that they, themselves, might be responsible. From my observations, I have come to the conclusion that the responsibility for the low percentage of young engineers who make good in industry lies in all three directions, i.e., the young man, the college, and industry. It is apparent, also, that considerable misunderstanding frequently exists on the part of all three. Some of the young men have false notions as to their importance, the rate at which they should be advanced, and the value and importance of practical experience gained over a period of years by men who may lack college education. The colleges may fail to recognize the difficulty of the raw graduate to adapt himself to industrial life; may fail to inform the student as to the requirements of industry, the rate of advancement that may normally be expected, and the value of a college diploma; and the methods of selecting students may be poor, with the result that some young men do not know until after their graduation from college that they have not the aptitude for engineering work in industry. Some employers take it for granted that the college-trained engineer is trained in detail for industry and are disappointed when they find that this is not so. They fail to provide training and supervision that are essential for these young men during the period of readjustment from college to industrial life.

It is unfortunately true that many college-trained engineers fail to attain more than mediocrity in industry. But similarly in all professions, lines of work, and walks of life, the percentage of individuals who are outstandingly successful is indeed low. In fact, my observations convince me that the engineer's record compares favorably with that of other professions.

For engineers as well as for individuals in practically all other lines of endeavor, the leading hinderances to success are due to personal traits rather than to the lack of technical ability. Recently the American Banking Institute made public the results of an investigation of the causes of discharge of 4000 office

For presentation at a meeting, New York, N. Y., May 12, 1938, to be held under the auspices of the Junior Group of the Metropolitan Section of The American Society of Mechanical Engineers.

employees of seventy-six important firms. The survey showed that only 10 per cent of those discharged lost their positions because of lack of ability to do their work. The other 90 per cent were discharged for reasons of a nature personal to the employees, such as carelessness, laziness, lack of cooperation, dishonesty, and lack of initiative.

WHERE THE YOUNG ENGINEER IS AT FAULT

It is true that many college-trained engineers are impatient for advancement, many have exaggerated ideas as to their worth to the company, and some take a superior attitude toward their fellow workers who have not attended college. These ideas and attitudes are, of course, not confined to engineers. The high-pressure recruiting methods that are followed by some firms are partly responsible for the student's mistaken ideas of his importance. Personnel officers start coming to the colleges as early as November to interview seniors, and some firms make tentative selection of the engineers fully two years before they graduate. In spite of the prevailing business conditions, all of the mechanical-engineering students who graduated from Columbia University last June had definitely accepted positions before the preceding February. Some had as many as three offers from which to choose. One student had been selected two years previous to his graduation. Part of the responsibility for the false notions of importance, therefore, clearly rests upon industry. College faculties must also share this responsibility when they allow these young men to go out into industry with mistaken notions. Students should be informed that recognition in industry comes only as the result of accomplishment which is achieved by long hours of hard work. Every student should also understand that the bare fact that he graduated from college entitles him to nothing, but that it will give him a tremendous advantage over his noncollege associates in opportunity to forge ahead. It should be pointed out to the student that, while he has been spending years in college, other keen, capable young men of his age have been receiving a practical training in industry, have become well acquainted and firmly entrenched in the organization, and have probably done considerable reading and studying. Not only must the college-trained man compete with these men who have a practical training, but he also has to make the sudden and severe adjustment from campus to commercial life. Perhaps he may even have an attack of homesickness. This is, therefore, a critical period in his career and many times does he become discouraged with his progress, especially when he hears of classmates and other friends who may be progressing more rapidly.

Before he leaves college, the young man's attention should be called to the complaint so often heard as to the superior attitude of college graduates toward noncollege men in industry. Although some college graduates do make this mistake, I have found that it is a matter of imagination on the part of many noncollege men. Nevertheless, the college man must be careful to avoid giving this impression. The matter of impatience for rapid advancement will take care of itself if the college and the employer will make it plain to the young man that it takes time and effort for the raw graduate to orient himself to the new work and that he must prepare himself and show himself ready for advancement. The company, especially, can do much to prevent misunderstanding by letting the young engineer know what progress he can normally expect to make if his services are satisfactory. It also should closely observe and supervise the young man in his work and relations with fellow employees and inform him, from time to time, whether his progress is satisfactory and in what way he is considered weak.

Lack of aptitude for engineering work is one of the reasons given for disappointment in the progress of young engineering graduates. We are also told that many students in engineering schools are not properly qualified and do not have the proper aptitude for engineering. Both statements are unfortunately true and are sad reflections on the selection by engineering schools and by industry. I look for the day when engineering-aptitude tests both by engineering schools and by industry will become important factors in selection of young engineers. Let me emphasize that I mean engineering-aptitude tests and not the usual intelligence, psychological, and achievement tests.

It is significant that so many firms find that students who have spent their summers working in industry and students of cooperative engineering courses become so much more quickly adjusted to their work after graduation and that failures among these men are fewer. These students naturally know what to expect when they enter industry and they know also, whether or not they are suited for this kind of work.

INDUSTRY'S RESPONSIBILITY

Many firms operate so-called training courses or programs for engineering graduates. Most of these consist essentially of having the young graduate serve for a short period in each of the departments of the plant. Unfortunately in most cases, the young man is allowed to shift for himself during this period, without encouragement, guidance, supervision, or training. He is compelled to pick up what information he can in a hit-or-miss way. As a consequence, many graduates flounder hopelessly for several years during this early period in industry, which is probably the most important in their industrial career. It is during this critical period that the severe adjustment from campus to commercial life must be made. New friendships have to be formed, and the young man is thrown on his own resources usually for the first time in his life. A carefully planned program under guidance and supervision shortens considerably the time required for training and personal adjustment, better prepares the young engineer for his work with the company, and greatly decreases the number of cases of dissatisfaction. I know of instances in which engineering graduates were discouraged and underpaid, their ability was unappreciated, and they made little progress under their first employer. These same men responded quickly and made more than average progress under their second employer, who offered guidance, encouragement, and instruction.

When hiring a college graduate, I think the company should make it plain that no assurance is given of a responsible position, progress will depend entirely upon accomplishment and attitude, and the college degree does not bear as much weight as the young man probably thinks it does. The young graduate should also be given an idea as to what progress he can normally expect to make if his services are satisfactory. Many students seem to have a wrong idea of what to expect.

Compensation is an important matter. The salary scale should be a fair one and provide for periodic increases. Some companies pay the beginner $175 or more per month, while I know of others that pay as low as $16 per week. It is certainly difficult for an employee of the latter to be contented and enthusiastic and to do his best work when he knows that his classmate is getting a higher salary.

ADVICE TO THE YOUNG ENGINEER

Some of the criticisms from industry regarding college-trained engineers have been mentioned. The young graduate should study them with profit. The following summary may be of help:

(1) Make a special effort to fit in quickly with your fellow workers remembering that industry places more importance on the ability to get

along with fellow employees than it does on technical knowledge and ability.

(2) Be ambitious, but do not expect rapid promotion to supervisory positions.

(3) Determine whether or not you really have the aptitude for engineering work in industry. If you do not have it, you will probably be happier and make better progress if you are transferred to some other kind of work. An engineering training is a good background for work in many lines.

(4) Cultivate the ability to adapt yourself to the routine of operating work without getting into a rut.

(5) Show willingness to prepare yourself for advancement, by continued study and reading and by familiarizing yourself with all phases of your company's business.

(6) If your company offers the opportunity of working for a period in each of the operating departments as well as in the engineering department, by all means give it your consideration. This method is one of the best to learn the details of a business and to become acquainted in the organization. But bear in mind that how much you will learn is entirely up to you. It will be well for you to outline systematically what information to look for in each department. Keep notes and study them. Study the product of competitors.

(7) Do not overestimate the value of your college degree, for it entitles you to nothing. Recognition in industry comes only as a result of accomplishment which is achieved by long hours of hard work. But your college training should give you a tremendous advantage in opportunity to forge ahead.

(8) Cultivate the ability to grasp the practical aspects of problems and situations.

(9) Cultivate a cost-minded attitude toward all problems that arise in the course of your work. Before making a recommendation, analyze it from the viewpoint of "Will it pay?"

(10) Practice report writing. Employers mention a general weakness of young engineers to express themselves effectively orally or in writing.

(11) Show enthusiasm and a willingness to work. Be willing to accept responsibility.

(12) Cultivate initiative, restrained by reason. Offer to do things without being told. Study processes, machinery, equipment, and product with a view of suggesting improvements, but be careful, in submitting your suggestions, not to raise antagonism.

(13) Do not get discouraged.

(14) Endeavor to find out from time to time whether your progress is satisfactory to your employer. Invite suggestions as to your weaknesses, so that you can try to improve.

(15) Broaden your interests outside of engineering. Although only about 15 per cent of the employers whom I have consulted stress the importance of nonengineering subjects when hiring young engineers, more than 50 per cent of all who answered the questionnaire believe that these subjects are essential to the success of any graduate and will help materially in making progress.

(16) Join a professional engineering society; attend its meetings; read its publications. Read technical and trade journals in your line.

Management and Employees

(Continued from page 402)

The basis for this is through understanding of procedures and policies. Various grades of responsibility are essential, but successful business depends on the harmonious functioning of the organization as a whole. The history of business in the United States is that of managers and executives rising from the ranks of employees, and, for that reason, no class distinction can exist between management and men. Practically, every top man in the country has been through the mill, and today's low-bracket employee may be tomorrow's manager. If class consciousness and a philosophy of inevitable conflict of interests develops in this country, it will be largely the fault of management.

I have touched on only a few of the elements of an industrial-relations program. Many other important matters, such as vacations with pay, annuity and insurance plans, sick benefits, and the like, which are recognized as part of the management-employee relationship have not been mentioned.

I have not spelled out a formula in detail to insure harmonious relations between management and employees—there is no one such formula. Rather, I have tried to set forth a philosophy of mutual understanding, confidence, and respect which might be summed up in the one sentence, that employees expect to be treated just as the management would like to be treated, not only because this is human justice but also because it is the essence of good business. Management, including supervisors and foremen, should lead off in this effort to understand the inner reactions of employees and strive to deserve the cooperation it expects and often demands. This is clearly expressed in an article, "Consultative Supervision" by H. H. Carey, published in the April, 1937, issue of *Nation's Business*, in the following words: "Nothing so stirs up resentment as action which affects us but about which we are not consulted."

New Emphasis in Management

(Continued from page 405)

dexterity; his mind efficiently, i.e., knowledge; and has the wherewithal to cope with variety and the unexpected, i.e., adaptability. We know that fatigue does not cause the skilled worker, who is well established in his habits, to lapse into wrong methods of work and susceptibility to accident. We know that the skilled worker gets satisfaction from his workmanship and interest in his work that tend to eliminate nervous fatigue which comes from doing work that one dislikes or does poorly. We know that we can eliminate fatigue through the technics of motion study and at the same time increase skill. If we are doing a good job, we have the maintenance and, where possible, the increase in skill in mind, while we are eliminating the fatigue.

One of the only partially explored fields of investigation in management has to do with the effects of motion economy, as it expresses itself in the similar two-handed patterns of work found in efficient assembly, on skill. We know that we can give the unskilled worker some skill, while eliminating his fatigue and teaching him to be motion-minded. We have in mind the great importance of making sure that we do not threaten any skill that he may have in using his hands in different work patterns, when we teach him to use them with the same work pattern. The relation of ambidexterity to bimanufiability has never been satisfactorily worked out on a scientific basis.

It should perhaps be said that we have been trying to show the new emphasis in management, i.e., that on the human element, by what is actually being done and thought rather than by the intention. Yet this last is really most important. Results of the trend cannot be measured entirely in tangibles. We can tell what we do and what the results are. It is not so easy to state the why, yet this is really most significant. For it has to do with fundamental causes. It sounds hard-boiled to say that we do it because it pays. But it does pay in money and in time and energy which are money. In better work methods, which are standards for work, inspection, maintenance, and measuring progress. In better industrial relations, because they are based on facts, found and faced. In cooperation, because that is the only thing which makes the fact finding possible. In the conviction that fostering the human element should be the aim of all activity. Ideals consistently followed have proved their value in results that cannot be questioned.

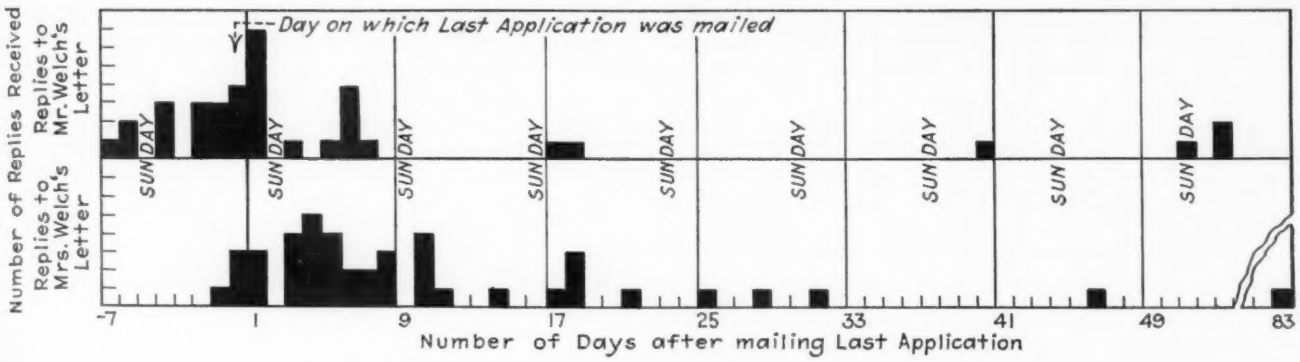


FIG. 1 TIME DISTRIBUTION OF RECEIPT OF REPLIES TO LETTERS APPLYING FOR JOBS
(Each black square represents one reply.)

GETTING A JOB

A Method That Brought Results to Two Young Engineers

By BETTY SLOCOMBE WELCH

HARTFORD, CONN.

WHEN my husband and I were studying engineering at college, we were told a good deal about how to get a job, but most of this information had to do with how to act when being interviewed by a prospective employer. When we found ourselves actually out in the world and in need of employment, we discovered that without personal contacts in the fields in which we wanted to work the difficult part of the problem was to secure the interviews for which we had been so well prepared.

What seemed to us the most important part of the situation facing us was to regard the problem not as a catastrophe that the world had unfairly imposed upon us, but as a job in itself, and a very exciting one, too. We therefore worked out a definite program that proved to be successful, and this program is being presented in the hope that it may be useful to other young engineers who are facing the problem of finding work. The program must, of course, be modified somewhat to suit individual cases. I can tell only what we did, why we did it, and how it worked.

PREPARE A LIST OF POSSIBLE EMPLOYERS

The first step in our procedure of getting a job is to make a list of all the organizations that hire people to do the work you can and want to do. This list should include as many names as possible, certainly not fewer than fifty, and preferably nearer a hundred. If you do not care about location, but are interested in work in a particular field, get the annual number of the best technical magazine devoted to that field that lists the names and addresses of companies. If you are interested in a particular product, use the A.S.M.E. *Mechanical Catalog*. If you are interested in a particular locality, consult the classified section of the local telephone directory.

The next step is to find the man in each company to whom you can make your application with the greatest prospect of success. The Membership List of the A.S.M.E. gives the companies with which members are connected, and the positions the members hold. Do not write to the personnel manager, as it has been shown in our experience that personnel managers are among the last to know when positions are open in the engineering department. If possible, therefore, find the name of the chief engineer. If an A.S.M.E. member holds a high position with a company for which you would like to work, write to him. From the A.S.M.E. Membership List can be found the names of the companies with which members are connected and the positions in these companies which members hold. If you cannot find the name of a high official, address your letter to the attention of the chief engineer. If the company is a very small one, it is better to write to the president.

The careful preparation of this list of companies, addresses, and names of executives takes about two days. The third step is to prepare a form letter.

A WELL-WRITTEN LETTER IS BETTER THAN AN UNINVITED CALL

We decided to write letters instead of making uninvited calls; and this decision was not an arbitrary one. Letters get into engineering departments, and usually applicants who make uninvited calls do not. If you appear at a plant, hat in hand, looking for a job, the first (and probably the last) person you will see will be the employment manager or a receptionist. If the company is looking for young engineers, and you are admitted to the office of an employer, the interview will not be prearranged and you will probably be introduced by a person of minor importance in the company. On the other hand, if you write to the chief engineer, and he is interested enough to ask you to call, he will see you himself, or will turn you over to one of his assistants.

If the company is not interested at the time you apply, and if you call in person uninvited, you will not get past the outside desk. If you are lucky, you will be allowed to fill out a blank

[When two determined young people find themselves out of work and hit upon a method of getting a job that proves to be effective, their experiences and procedure should be helpful to others. Mrs. Welch and her husband are Junior Members of The American Society of Mechanical Engineers.—EDITOR.]

that records your qualifications. Perhaps the person you see will simply take your name; and too often these names are written on small, odd-sized pieces of paper, destined for the wastebasket as soon as your back is turned. In this case, there is no possibility whatever of your being called to a position with that company when one is available. However, if you have written to the president or chief engineer, the letter will probably be filed somewhere in the engineering department where the opening you desire will be known about first, and it is then possible that you may receive a call from that company some time in the future.

PREPARE A QUALIFICATION SHEET TO ACCOMPANY THE LETTER

In deciding what to put in our form letters, we tried to think what the men to whom we were writing would read. We decided that the shorter our letters were, the more likely they would be to get attention. However, as a short letter would not contain all the information we wished to convey, the solution was a brief letter accompanied by a qualification sheet, which contained, in tabular form, the information a company would be likely to want recorded on its own employment blank. Such qualifications can be grouped under five main headings: Personal, education, affiliations, experience, and references.

Under the "personal" heading are included name, age, height, weight, marital status, nationality, and perhaps religious affiliation.

The "education" section should contain the college and year of your degree, the major subject of your studies, and the special courses that are most closely associated with the work for which you are applying. If you have studied in a trade school or taken a correspondence course, or if you know a foreign language or can operate a business machine, say so. Extracurricular activities, such as debating clubs and editorial boards of college papers, may also be included here.

"Affiliations" should list A.S.M.E. membership, any military rank, and honorary society or fraternity. Your prospective employer may be a member of one of these groups, and hence this fact may work out to your advantage.

"Experience" should include all summer jobs and part-time work that is pertinent. For each of these jobs, list the length of time it was held, the position, the nature of work, the date started to date finished, and the name and address of the company.

"References" should be former employers, professors, or the dean of your college, or any others who hold positions of responsibility and who are familiar with your work. One or two character references may be included—your local minister, or a lawyer, architect, or doctor who is a family friend. Relatives' recommendations usually do not carry much weight. Before using anyone's name as a reference, ask if you may do so. Tabulate names, positions, and addresses of your references.

Unless your experience has been unusually long, you should be able to get all this information on one page. A neat and clear arrangement of this sheet is worth a good deal of time and trouble. Work out the spacing carefully on a typewriter until you are satisfied that the format is good, with the headings standing out, and the material arranged so that any point may be seen at a glance. Avoid abbreviations when possible.

SOME POINTERS ON LETTERS

The letters are much easier to prepare than the qualification sheets, although they vary slightly with each application. They should be in regular business form, with your address and date at the upper right-hand corner. Below and at the left go the name and address of the company, and under that, "*Attention: Mr. John Doe.*" This is better than writing directly to a certain man in the company, as the man whose name you have may have died or left the firm. State at once that you are an engineer, and that you would like a job. Make the paragraphs of the letter short. Say that you are enclosing a qualification sheet, and offer to furnish any further information desired. If the company is located at some distant point, offer to send a photograph, and have on hand about twenty small ones ready to send out. The photographer who took your picture for the college yearbook can probably supply these for a modest sum. We do not suggest enclosing the photograph with the application, because even a modest sum becomes an important one when it is multiplied by eighty or so. If the company is nearby, conclude the letter by asking for an interview. It is well to give your telephone number, although this will probably not be used. If there is some reason why you think you will be of particular value to the company to which you are writing, tell about it in a line or two. It probably does more harm than good to say how deeply you admire the company's product, because such statements will inevitably sound insincere in a letter applying for a job. A letter of application that tries to be something it isn't, is doomed to failure.

MAKE A REAL JOB OF WRITING THE LETTER

Careful preparation of a form letter and qualification sheet will require about a day, and then you are ready for the real work of getting a job. The qualification sheet and letters must be typewritten. Handwritten letters, even in beautiful script, look amateurish. If you do not own a typewriter, rent one. You do not have to be an expert typist for this job, but you do have to work carefully. There must be no typographical errors and no obvious erasures in the letters you submit to represent you and the work you can do to the man you want to hire you. A public stenographer can do the typing, but she will probably charge 10 cents for a letter and 20 cents for a qualification sheet if it is on one page. Thirty cents a letter means twenty-one dollars for a list of seventy, and few unemployed engineers have twenty-one dollars to spare.

The longer your list, the greater will be the temptation to use carbon copies of the qualification sheet, but we feel strongly that these should be typed individually. A carbon copy puts your record in a class with printed or mimeographed advertising matter, and it will neither deserve nor get the attention given by executives to individually typed letters. Use a fairly good quality of regulation-size letter paper, and mail the letters in stamped envelopes. Find out how many letters you can type in a day, and then make a schedule of output for each day so that you will be working approximately eight hours. An expert typist can type about twenty a day and a beginner at least four or five. After mailing each day's stint, forget the whole thing.

The time required to get out all the letters will depend, of course, on the length of the list and your typing speed, but soon after the last batch of letters has been mailed, and usually before this, the replies will start to come in. Most of those that do not say "no opening at present" will probably ask for further information or an interview, and from then on, it's clear sailing. You simply do what each letter requests, being more careful than ever, because now you are dealing not merely with "shots in the dark" but with men who are actually interested in you. Interviews are of the utmost importance, but at college you were told how to "sell" yourself once you are in the presence of the chief engineer.

SELECTING THE JOB YOU WANT

The last step in this process is selecting the job you want most. Be sure that the work will be fun, and that you can do it well. If the location is satisfactory, the salary enough for

your needs, and the future good, you have found your job. If you do not secure the job you want at once, send "follow-ups" every few weeks. A man I interviewed once told me: "Keep on my trail. Right now I have your qualifications in mind, and intend to offer you a position as soon as we have an opening. But if we don't have one for several months and I haven't heard from you, when the opening does come there will be someone who has applied more recently. Even if he's not so well suited for the job, he'll probably get it unless you keep reminding me about you."

If you do not get any offers at all, it is a pretty sure indication that either the type of work you have selected or your qualifications are at fault. If you are determined to get into that particular field, look over your qualifications, decide where they are weak, and take the steps necessary to fit yourself for the position you want.

HOW THE PLAN ACTUALLY WORKED OUT

This, then, is the outline of the method we worked out for ourselves. The best recommendation we can give it is that it worked for us.

I narrowed my choice to the field of aviation. The A.S.M.E. Membership List contained names of about forty men in various aircraft and engine companies, and other names were found in the annual listing of the *Aero Digest*. There were eighty companies in all. The *Aero Digest* gave also the names of the companies' executives.

My qualification sheet had four main headings—Education and training, experience, miscellaneous, and references. To help in getting a job, I studied shorthand and typewriting at home until I had acquired speeds about a third those of a good stenographer. Under "education and training," I listed first my engineering degree, and then my stenographic ability. I included service on the editorial boards of two college papers, and my A.S.M.E. affiliation.

My experience had been acquired largely as part-time work of various sorts, mostly helping professors. This would not have looked very impressive if listed as a week or so of this and two afternoons a week of that, so the "experience" section contained only a listing of the types of work I had done: stenographic work, computations, drafting, and operating certain office machines.

Under "miscellaneous" were listed my age, the fact that I had no dependents, the offer to send my photograph and further information, a very general statement about the salary expected, and my salary at the time of writing.

My "references" were in two sections—employers and others. The three employers were all professors, and the others were the dean of our college, a professor of philosophy and a doctor who were family friends.

My husband's campaign was somewhat different. Any manufacturing concern would offer the type of work he wanted, but he limited himself to a particular locality. His list was culled from the A.S.M.E. Membership List and the local telephone directory. His handicap was the current business recession; he sent out his letters during the end of December, 1937, when most concerns were laying off employees.

Charles Phelps Cushing

Although my campaign was conducted when business conditions were near their recent high, and my husband's at the depth of a recession, the number of returns was nearly the same. Fig. 1 shows when the answers were received. Answers to my letters came later, in general, than those to my husband's, because the companies to which I wrote were widely distributed, whereas my husband's were local.

Most of the answers were received within two weeks after the last letter had been sent, and nearly all within a month. The very late answers, however, usually contained offers of jobs or very good leads. The bulk of the prompt answers that came in the first week contained many flat "no's," but often the offer of a job appeared very promptly. After about a week and a half, during which letters were presumably written to and received from references, I received several telegrams asking what salary would be acceptable. Usually, a definite offer was not made until references had been investigated or I had been interviewed.

Statistics of the answers received are shown in Table 1.

TABLE 1 ANALYSIS OF REPLIES RECEIVED

	Replies to Mr. Welch's letters	Replies to Mrs. Welch's letters
Total applications sent out	64	80
Answers, per cent	55	54
Refusals, per cent	36	24
With slight encouragement, per cent	9	7
With possibilities, per cent	3	5
With probabilities, per cent	2	9
With jobs, per cent	5	9

It is interesting to note that before my husband launched his letter campaign, he had called at several employment offices, with badly discouraging results. At one plant, the employment officer started shaking his head as soon as he saw my husband coming, and refused even to take his name. This company was included in the letter campaign a few days later, and the first job that resulted was with the same company.

The first job offered my husband was that of laboratory assistant at a very small salary; the next, as a student working through a plant at a slightly higher salary; and the last, as a plant engineer at a salary nearly double what he had been paid as a student.

I accepted the job with the highest salary without stopping to find out just what the position was, and was greatly embarrassed to find myself private secretary to an executive vice-president. As my engineering training was of no value, and as my secretarial training was sketchy in the extreme, the company that hired me was embarrassed, too, and fired me in a week.

My next choice, needless to say, was work that I was equipped to do, but at a somewhat lower salary. I recommend the latter procedure. It is much more satisfactory than being fired.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Day by Day

ANNIVERSARIES and celebrations seem once more to take an important place in these day-by-day comments. After all, it is easier to remind readers of the past than it is to prophesy what the immediate future will be, and an attempt to evaluate the significance of events of a century ago leads to less controversy than do pronouncements on contemporary trends. National planning, Arthur E. Morgan and the TVA, the causes of the recession, what to do with the railroads, Commissioner Walker's report on the A.T. and T., and housing are tempting subjects for a commentator, but the state of one's reputation and blood pressure are better served by leaving the task to others, and trying to get what comfort and perspective may be had from looking backward over the road we have traveled.

For mechanical engineers the last century has been a remarkable span of years, and unless we take a look at it occasionally we are likely to fall into the error of believing that progress has ceased or that technology has always been as widespread and as fully developed as it is today. Macmillan has recently published a book by Edward Cressy, entitled "A Hundred Years of Mechanical Engineering," in which the technological record of the past century has been placed in a convenient form. The fact that the record has been compiled by an Englishman does not destroy its value to a reader in this country because an earnest attempt seems to have been made to recognize developments on this side of the Atlantic. Moreover, most of us are so provincially minded that it comes as a surprise to us to be reminded that technological evolution was not confined wholly to this country. Mr. Cressy's story, quite naturally, deals principally with the production, distribution, and applications of power, but it also contains a section devoted to materials and processes. For an engineer who wishes to withdraw temporarily from the confusion of a world in social, economic, and political ferment Mr. Cressy's book may provide one means of escape. And perhaps the reader will lay it down with a renewed faith in mankind and engineering.

Iowa

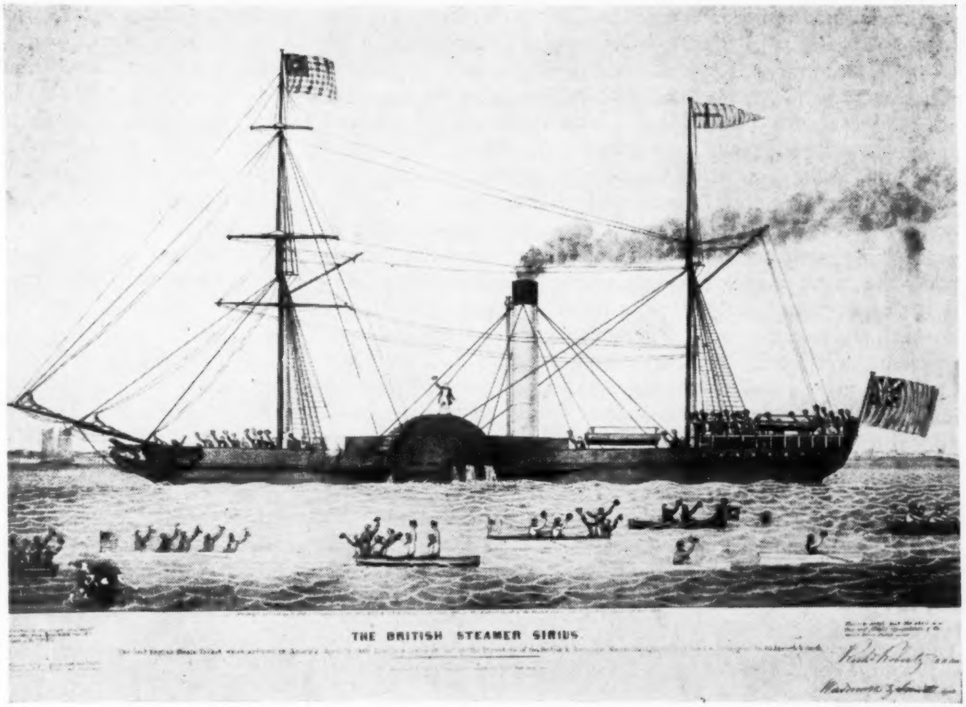
To celebrate its fiftieth anniversary the Iowa Engineering Society has published a historical pamphlet, "Fifty Years of Engineering Leadership," by John S. Dodds, since 1924 secretary-treasurer of the state society. Professor Dodds' year-by-year record of the ups and downs of the society is a story reflecting the impact of the times on a group of engineers in Iowa, and the engineering topics to which they directed their attention.

It is a brief, factual record. Only at one or two points does Professor Dodds permit himself to comment, as when he pays a tribute to the engineering colleges. But from the excerpts of presidential addresses, from a few matter-of-fact statements, a curt word here and there, and mostly from between the lines can be seen the fabric of American life for the period covered—the earnest attempts of honest men to attend to their own affairs and make the best of what each day brings forth. Modesty and sincere idealism; faith in the best aspirations held by men possessing a professional consciousness and striving to develop it with courage; a sense of obligation to the welfare of their fellows; enthusiasm that led to expansion when the entire country had expansive ideas; the depresssion of the early twenties and the more serious effects of the dark days from 1930 on; budgets sternly calling the tune; 1932, with the comment, "The banks folded up and tied up our treasury early in the year. Engineers were laid off and enrollment in the colleges dropped," briefly telling the story; efforts to help the unemployed engineer; better times; and 1938 with the society still going on, like the familiar close of a Greek drama—always a tomorrow—reveal as much as hundreds of pages of profound philosophizing might do at another's hand.

"Sirius"

On St. George's day, April 23, 1838, lower New York was the scene of intense excitement and jubilation. The *Sirius*, first steamship to cross the Atlantic, had arrived outside the harbor the day before, 18 days out of Cork. Decision on the part of her owners to risk the voyage had been made in an effort to beat the *Great Western*, which also arrived on April 23, having made the crossing from Bristol in 15 days and 5 hours. The "Atlantic Ferry" had suddenly become a possibility.

Celebration of this noteworthy event was observed in London on March 16, 1938, when the Newcomen Society for the Study of the History of Engineering and Technology met at the Science Museum, Sir John E. Thornycroft, K.B.E., presiding, to hear Eng. Capt. Edgar C. Smith, O.B.E., R.N., Ret., president, read a paper, "The Centenary of Transatlantic Steam Navigation." In preparation for the centenary exhibits had been prepared consisting of the actual figurehead of the *Sirius*, a dog, holding between its front paws the Dog Star, Sirius, from which the ship took its name, and a scale model of the paddle steamer itself, of 703 tons gross, built of wood in 1837 for cross-channel service between London and Cork, and fitted with a two-cylinder side-lever engine driving cranks at right angles. The accompanying engraving, by courtesy of H. M. Lydenberg, director of the New York Public Library, depicts the joyous arrival of the steamship. From Captain Smith's paper, to which are appended excerpts from the so-called "Field Papers," preserved in the Science Museum Library, details of the construction and machinery of the *Sirius*, the *Great Western*, and other early steamships, may be obtained. As for the *Sirius*, her engine cylinders were 60 in. in diameter, the stroke was 6 ft, nominal horsepower 320, and diameter of paddle wheels 24 ft. Steam pressure was about 5 lb per sq in. and the paddles turned at about 15 rpm. Throughout the entire trip the engine did not stop. Out of 453 tons of coal she consumed 431 and 43 barrels of resin.



BRITISH STEAMSHIP "SIRIUS," FIRST TO MAKE THE WESTWARD CROSSING OF THE ATLANTIC OCEAN BY STEAM, ARRIVING IN NEW YORK APRIL 23, 1838, FROM AN OLD PRINT

She was fitted with Hall's surface condenser and made the entire voyage using fresh water.

On April 4, 1938, one hundred years after the beginning of the epoch-making departure of the *Sirius* from Ireland, members of the American Branch of the Newcomen Society celebrated the centenary of this first crossing under steam power at a dinner held at the Union League Club, New York, C. E. Davies, secretary, A.S.M.E., junior vice-president for North America of the Newcomen Society, presiding. Papers were read by Rear-Admiral H. G. Bowen, engineer in chief of the United States Navy, chairman, the Atlantic Centenary Committee, Charles Penrose, member, A.S.M.E., senior vice-president for North America of the Newcomen Society, and Joseph Mayper, chairman, Trans-Atlantic Passenger Conference. Mr. Penrose presented a graphic description of the *Sirius* and her crew, the wild welcome at New York, and the influence on the minds of men recovering from the depression of 1837 excited by the promise of this new means of transportation. His gleanings from the contemporary newspapers of England and America clearly demonstrated the importance with which this historic event was heralded by those who witnessed it, and the effect upon the imagination and editorial policies of James Gordon Bennett, rising young journalist, who returned in the *Sirius* to attend the coronation of Queen Victoria and establish a foreign service for his paper. Mr. Penrose visualized the establishment of transatlantic steam navigation as a challenge to the men of that day, and one which is still held out to us today.

Mr. Mayper, whose subject was "Atlantic Transportation—Today!" reviewed important factors in the development of steamships and their services on the Atlantic, with particular attention to superliners, and painted vividly the contrasts of the old and the new. He also called attention to the effect of steam transportation on the port of New York, "chosen gateway for approximately 83 per cent of the country's overseas passenger travel, and for about 40 per cent of the entire foreign commerce of the United States which in 1937 exceeded $6,000,000,000." In closing he called attention to the recent report of the Maritime Commission, frequently mentioned in these pages, in which cognizance was taken of the possibility of regular airplane flights between this country and Europe, and referred to some of the important water-borne ships now under construction.

Preservation

Treatment of wood by chemicals to retard decay celebrates its centenary this year, according to *Wood Preserving News*, which recalls that in 1838 two British patents were issued, one to John Bethell, on methods of treating wood under pressure with creosote, and the other to Sir William Burnett on methods of treating with zinc chloride. The same processes, with improvements and modifications, are in use today.

The first recorded attempt made in this country to treat wood under pressure was in 1865, at Somerset, Mass., by the Old Dighton and Somerset Railroad and applied to bridge piles. The plant, equipped with one cylinder 64 ft long, operated on a 12-hour day and turned out 12 piles daily. Today this country has 170 pressure plants, with treating cylinders up to 175 ft in length and 6 to 9.5 ft in diameter.

Durley

On March 18 the President and Council of The Engineering Institute of Canada announced the retirement as secretary of the Institute of Richard John Durley, member since 1899 of The American Society of Mechanical Engineers. Captain Durley becomes secretary-emeritus. The duties of the secretaryship were taken over on April 1 by Leslie Austin Wright.

Captain Durley became secretary of the Institute in April, 1925, and in June of that year assumed editorship of *The Engineering Journal*, official publication of the Institute. Educated in England at the University College, London, he acquired by apprenticeship and engineering practice a background of experience that lent authority to a teaching career begun at Hull, England in 1894 and continued at McGill University, Montreal, when he went to Canada in 1897. Through his teaching, his consulting practice, his service during the war as officer in

charge of the Division of Gauges and Standards, Imperial Ministry of Munitions, Inspection Department (Canada), and his work as secretary of the Canadian Engineering Standards Association he became favorably known to Canadian engineers and added to his professional qualifications those personal characteristics that made his selection, in 1925, as secretary of The Engineering Institute of Canada a fortunate choice.

Spread out over a narrow strip of territory extending from ocean to ocean in a country where great pioneering works of engineering construction and development are going on simultaneously with highly progressive manufacturing establishments of the most modern type, a country rich in agricultural, mineral, and natural power resources, members of the Institute represent every phase of engineering practice. It has been Captain Durley's task to coordinate these diverse professional interests during a period of economic stress and in the face of difficulties inherent in the wide separation of industrial centers and the even more extensive scattering of the districts that make up the engineering frontier. As editor of the *Journal* of the Institute he produced an engineering magazine of high quality, recording the best developments in technology in Canada. Fortunately his services are not lost to the Institute and the *Journal* for, as his health permits, he will continue to be active in both.

Merica

In an excellently written biography of the recipient of the 1938 award of the John Fritz Medal, the career and metallurgical contributions of Paul Dyer Merica, vice-president of the International Nickel Company, are briefly but thoughtfully appraised. The medal, highest honor in the engineering profession, was awarded at a dinner at the Metropolitan Club, New York, under the auspices of the American Institute of Mining and Metallurgical Engineers, celebrating the medalist's forty-ninth birthday, on March 17, 1938, in "recognition of his important contributions to the development of alloys for industrial uses." Merica shares with Marconi the distinction of being the youngest to receive this award.

Merica, whose father served as president of several colleges in the West, developed an early interest in chemistry, and, following graduate studies at the University of Wisconsin, went out to China as a teacher, where he became interested in metallurgy. Going to the University of Berlin in 1911 for further study, decision to follow metallurgy as a career was made. In 1913 Merica, returning to this country, became associated with G. K. Burgess in the newly organized Division of Metallurgy at the Bureau of Standards. Here, because of interest in light metals aroused by the use of airplanes in the war, Merica undertook studies in aluminum alloys, a subject he had investigated in Berlin, and, with Waltenberg and Scott, published an epoch-making paper setting forth discovery of the mechanism whereby quenched duralumin hardens on merely standing for a time at room temperature. Says the writer of the brochure, "Merica's precipitation-hardening theory proved of general applicability in the field of alloys and later experience showed that precipitation-hardening is involved in the hardening not only of ordinary and high-speed steel, duralumin, and its variants, but in a whole gamut of permanent-magnet alloys, precious-metal dental alloys, and a number of useful copper- and nickel-base structural alloys."

Merica's brilliant work attracted the attention of A. J. Wadhams, then superintendent of the Orford Works of the International Nickel Company and led to the engagement of the metallurgist by that concern, thus initiating a career rich in research that resulted in the development of many new alloys, for it is one of Merica's unusual gifts to be able not only to develop new materials but to win for them engineering acceptance and use. His services to the International Nickel Company have been recognized by steady promotion to positions of greater responsibility—technical assistant to the president in 1930, director in 1935, and vice-president in 1936. Author of some fifty articles and monographs and sole or joint inventor of alloys and processes covered by 70 patents, he has been an active member of technical societies, and has been the recipient of many honors in the form of medals and degrees.

Railroads

Addressing the Chicago Association of Commerce on Feb. 9, 1938, Ralph Budd, president, Burlington Lines, had some things to say on opportunities for betterment of the railroads. "How healthy should our railroads be in order to function best and cheapest?" he asked. "My answer," he continued, "is that they should have the most suitable cars, locomotives, shops, terminals, tracks, and structures that science and invention can make available. The increased efficiency and improved quality of service which have characterized railway progress in this country have resulted from liberal capital expenditures throughout the years. Only in this way have managements been able to absorb mounting costs of labor, material, and taxes." Developing these ideas, he said:

From the standpoint of physical improvements and performance, the present situation is most fortunate because there are so many ways in which railroad facilities can be improved. After some years of subnormal replacement the time has come to install many new cars and locomotives. Phenomenal new metal alloys have revolutionized the relationship of weight and bulk on the one hand to strength on the other. Streamlined trains of aluminum and stainless steel that weigh about half as much as the old standard equipment have dramatized these facts. More important is the application of the same principle to locomotives and freight cars. Modern engines will haul heavy trains at higher speeds and cover many more miles per day; the use of alloys in rods, pins, and other reciprocating parts greatly reduces their weight, and consequently the "pound" on track, giving an all-around increase in efficiency over the older types that may be replaced. In 1937 the Burlington built 1000 box cars using moderate amounts of alloy steels. When they were completed their weight and capacity were compared with 1000 similar cars built in 1928 of what were then standard materials. The 1928 cars weighed 24.4 per cent more per cubic foot of capacity than the 1937 cars. The cost of maintaining the 1937 cars will be substantially less; when a train of these loaded cars is handled more of the weight will be pay freight and when the cars are handled empty the cost of moving them will be less. There are 2,000,000 freight cars in the United States with an average age of 17 years, and 45,000 locomotives averaging 20 years old. 100,000 new cars and 2000 new locomotives a year, for many years, can be justified economically, provided a constructive national railroad policy is adopted and followed consistently so as to restore railroad credit, that is, financial health. Similarly, the track and structures, shops, machinery, and tools can be modernized advantageously if obsolescence can be regarded as an opportunity instead of a near-calamity.

Formerly railways so dominated the field that their charges for freight and passenger services were almost synonymous with the nation's transportation bill. Now, with four other forms, waterway, highway, airway, and pipe line, the railway

bill is only about one fourth of the whole, that is, four billion of a total of 16 billion dollars a year. Much of the other 12 billion represents the cost of operating 24 million automobiles and is part of our way of living; but nonetheless it is transportation. Looking at the picture as a whole and granting that railway services are essential to our business and social life, it would not seem that the difference between starvation and sustaining railway revenues would be a serious obstacle to a nation which has voluntarily doubled its investment in transportation plant and voluntarily trebled its annual transportation bill.

Record

A nonstop flight of 5278 miles, said to be a distance record for seaplanes, was reported on March 29 in a dispatch from Berlin to the *New York Times*. The plane, a Dornier DO-18, equipped with two Junkers heavy-oil engines, piloted by Captain Hans Werner von Engel, was catapulted from a ship anchored off Dartmouth, England, and 43 hr later landed at Caravellas, Brazil, bearing a crew of four. A German catapult ship was briefly described in the October, 1937, issue of Mechanical Engineering, page 770.

Photoelasticity

The spectacular growth of photoelastic analysis as a tool for designers of structures has developed to a point where a magazine, ***Photoelastic Journal***, devoted to stress, polarized light, and plastics, has made its appearance. The editor of the new journal is Arshag G. Solakian, some of whose papers on photoelastic stress analysis and photoelastic materials have been published by The American Society of Mechanical Engineers. The objectives of the journal, as announced in its first issue, January, 1938, are: To make the photoelastic method of stress analysis simple in principle, practical in application, and popular in use; to develop photoelastic research with a view of applying it to the economic and safe design of machine and structural elements; to develop a close contact and cooperation between photoelasticians and industrial organizations; to keep the reader informed with up-to-date developments of photoelasticity and related subjects here and abroad; and to make photoelasticity accessible to a larger group of students, teachers, researchers, practicing engineers, and industrial organizations.

Speed

From time to time speed records are published and compared with statements concerning the speed attained by animals, birds, and insects. For example, Dr. Charles T. H. Townsend is said to have estimated the speed of the male deer fly at "400 yards per second," or 818 mph. This remarkably high speed appeared excessive to Dr. Irving Langmuir, who reports on the subject in the March 11 issue of *Science*. Dr. Langmuir, therefore, made some simple computations and experiments. He arrived at the conclusion that at this speed, "the wind pressure against the head of the fly [diameter 1 cm, speed 818 mph] amounts to about 8 pounds per square inch or more than half an atmosphere, probably enough to crush the fly. The power consumption needed to maintain this velocity of 818 mph would be 3.7×10^9 ergs per sec or 370 watts or about one-half horsepower—a good deal for a fly." Then, assuming that a fly cannot do much better than a man when it comes to energy conversion, since even man has a rather high thermodynamic efficiency, he decides that "the insect, to deliver 370 watts, must consume 0.31 grams per sec or 1.5 times his weight of food each second!"

Inasmuch as Dr. Townsend had estimated the speed from the "brownish blur in the air" as the insect passed him, Dr. Langmuir tied a solder pellet, about the size of a fly, to a light silk thread and swung it in a vertical circle at timed speeds from 13 to 64 mph. At 13 mph, he reports, the "fly" was merely a blur, at 26 mph it was barely visible as a moving object, at 43 mph it appeared as a very faint line and the direction of rotation could not be recognized, and at 64 mph the moving object was wholly invisible. "The description given by Dr. Townsend of the appearance of the flies," he says, "seems to correspond to a speed in the neighborhood of 25 mph." Man's speed in the air seems still to hold the record.

Unrecovered

What is in the sea beside fish and water is set forth in a release, recently received, relating to the bromine plant of the Ethyl-Dow Chemical Company plant at Kure Beach, near Wilmington, N. C. Of the long list of chemicals mentioned, bromine is the only one commercially recovered, and this has been used as an ingredient for a motor-fuel antiknock compound. Says the release:

During the four years of operation at the Kure Beach plant, one square mile of water 354 feet deep, or 634,366,000,000 pounds of brine, has been treated in the process of extracting bromine. In this volume of water were unrecovered chemicals with a total tonnage of 11,615,686.21, which would bring at the current market $383,335,200.

These substances and their values included: Sodium chloride (common salt), 8,538,000 tons, $128,100,000; magnesium sulphate (Epsom salts), 2,167,000 tons, $86,600,000; calcium chloride, 470,300 tons, $10,820,000; potassium chloride, 243,650 tons, $20,436,500; magnesium, 194,900 tons, $136,400,000; aluminum, 554.2 tons, $232,500; strontium carbonate, 642.9 tons, $386,000; iron, 582.8 tons, $46,550; copper, 36.92 tons, $19,200; iodine, 12.89 tons, $29,650; silver, 6.30 tons, $96,800; gold, 0.20 tons, $168,000.

Labor

On March 28 the National Industrial Conference Board, New York, N. Y., released a comprehensive study entitled "Differential Wages and Hours in the United States." The study gives detailed information on the wages and hours of more than 740,000 workers in nearly 200 separate occupations in eight leading industries. High lights of the study reveal:

Average hours of work tend to be shortest in the Far West. The South has the longest hours in the lumber, furniture, and electricity industries and the shortest in the cotton textile industry and in foundries and machine shops.

Average hourly earnings of male workers are highest in the Far West in foundries and machine shops, and in the furniture, lumber, printing, and paper and pulp industries. Weekly earnings average higher in the East in four of the seven industries covered. Both hourly and weekly earnings are lowest in the South.

Big business tends to pay higher wages than small business, but women workers earn more on the average in the small plants.

Hourly earnings are from 15 per cent to 35 per cent lower in small communities than in the larger cities. There is less variation in weekly earnings. Comparison of earnings in

identical occupations shows that women receive less pay than men.

Existing variations in the cost of living are not sufficient to account for the differentials in wages on a regional basis.

Paternalism

Reflections by a British contemporary, *The Engineer*, March 4, 1938, on that part of the National Resources Committee Report of last summer which said that it is "a function of government to watch over and adjust the serious strain and friction which invention may set up in society," go to the heart of the question raised by acceptance of such a statement. Says the editorial in question:

Let us try to imagine an invention of the first order which is not outside the bounds of possibility, and consider the attitude that a paternal Government should assume toward it. The direct generation of electricity from coal gives us the kind of example we want. It would render all steam plants with their multiplicity of associated components antiquated, and would dislocate or disturb the great industry which is engaged in the manufacture of power plants for land and sea; the importation of fuel oils would decline to an infinitesimal amount; electricity would become as cheap as water; the railways would all be electrified, and even motor cars might use "juice" in place of "gas." One cannot foresee all the consequences that might ensue, but one can see without difficulty that great social disturbance would result. Let us now ask ourselves what ought the attitude of a paternal Government be as soon as it took cognizance of the invention. It could refer the matter to a committee of economists and scientists. But even a committee of experts would hesitate to express an opinion extending more than a few years into the future. Its temerity would be restrained by the numerous examples of the total failure of prophecy in a hundred scientific and technical matters. It might, indeed, decide that in order to minimize the dislocation of labor, only a certain number of kilowatts of the new electricity should be produced in a period of years. A useless decision, for the change would in any case be slow. Or it might imitate the tactics of our forefathers with regard to railways and electricity supply; that is to say, it might by statutory means hamper the progress of the new invention. Would anyone thank it for that action ten or twenty years later? By that time other countries which encouraged inventions instead of endeavoring to adjust them to the social conditions, would have advanced by application of the invention, and by taking a venture on the unforeseeable results that might spring from it. Or the committee—for committees of the wisest men often reach foolish decisions—might so restrain the invention that it never gained a footing in its native land, and some years later returned as an alien product with the usual payment of licenses to foreign patentees.

Hitherto, all advanced countries, in deference to the opinion of well-informed authorities, have sought to encourage invention rather than restrain it. That is the avowed object of all patent laws, the purpose of all state-aided research, and one of the principal justifications for industrial subsidies. To reverse that policy, to attempt to restrain the progress of invention, would, we submit, be as unwise as it would be unnecessary. When inventions are in fact "improvements," as they are called in patent specifications, the natural inertia of industry may be trusted to restrain their development. Such dislocation of labor as they effect is never sudden; there is time for accommodation to be made with the new conditions. When inventions bring something new to the world, as, for example, radio-telephony and television, it goes without saying that every encouragement that the state can give should be forthcoming. Every new invention of that order causes an increase in the demand for labor of all kinds, and accelerates the circulation of money. How, then, can the state exercise control of inventions usefully when on the one side it is supererogatory and on the other the very reverse of what is desirable? The answer, we think, is clear. There is nothing that it can do that will not be ill done. The object of the control is to prevent social disturbances; but we may well ask if it is not better to suffer that temporary evil than to do something that may delay the rate of progress of industry through the natural development of inventions?

Warning

Commenting on the proposed plan of Western Union engineers to plow a ditch in the ocean floor in which to lay cables for their greater protection, an editorial in the *New York Times* said recently:

It is the old, stupefying theme. This creature called man can plow the bed of the sea with a plow almost a mile long, and lay in it a cable to carry human thought instantaneously between the continents. He is the same creature who hurls down bombs on women and children from a height of 15,000 feet. The miracle worker of the electric waves is the same creature who suppresses and throttles and shoots and starves his fellowmen in the mad sweep of his hates, which he calls his ideologies.

But let us not make the all too common mistake and say what a much better world this would be if it were ruled by its cable engineers instead of its politicians. The thing has been tried, and it only means spoiling a good engineer to make one more booted and spurred autocrat. Give the engineer power over men as he has power over materials and the forces of nature, and he will start in to play with the lives of men. He will plow human life into his schemes as the engineers expect to plow the Atlantic cables into the bottom of the sea.

Strength of Materials

Mechanical engineers, as a rule, have very little to do with concrete or wood in their design work, and therefore do not realize the potential uses of these materials. John M. Lessells, member, A.S.M.E., and associate professor at the Massachusetts Institute of Technology, in explaining the reasons for setting up a special course to be given at the Institute (see page 451), asserts that the application of any kind of material depends very much on the extent of available knowledge underlying its strength. He says that H. G. Wells in his "Short History of the World" states that nothing in the previous practical advance of mankind is comparable in its consequences to the complete mastery over enormous masses of metal which man has now achieved. If this is true, it is undoubtedly because, during the last fifty years, there has been a very concerted effort in studying the behavior of alloys of iron and carbon, which alloys represent another way of describing steel and cast iron. Such knowledge has enabled us to understand the beneficial effects produced by mechanical working of the metal or by the judicious use of additional alloying elements, so that the strength of steels can be varied at will from the 40,000 lb per sq in. of pure iron to some 300,000 lb per sq in. for cold-worked material. The state of the knowledge is also such that the structural characteristics as revealed by the microscope are well understood and in general, by the use of such methods, a fairly good estimate as to the history and strength of the material in

question can be obtained. In other words we can say that our knowledge is based on the fundamental understanding we now possess of the structural characteristics. The result is that enormous steel structures are more or less commonplace.

These developments in the use of steel may have distracted attention somewhat from the developments in the use of other important materials such as concrete and timber. Nevertheless, constructions like Boulder Dam, in which large masses of concrete form the basis of the structure, and large wooden arches, made possible by the use of laminated wood, fabricated from glued sections, have also become actualities. While the knowledge surrounding the basis of strength of such materials is not so extensive as in the case of steels this is being continually extended. The strength of steels can be varied over a wide range. With regard to wood, surprising as it may seem, we still do not exactly know what it is. Its strength largely depends on what is supplied by nature during its growth even though steps are being made to control growth to give certain desired properties, and very decided progress has and is now being made to arrive at a better understanding of its structure. Concrete represents a material on which our extent of knowledge lies somewhere between steel and timber since the strength can be considerably varied by the aggregates employed. Comparatively recent work also indicates that its strength can be increased many fold by subjecting the material to compression during the setting period. Comparing available knowledge on these three materials, the strength of steel can be varied at will over wide ranges, while that of concrete can be somewhat modified by the mix employed and by pressure, and that of wood depends entirely on what nature provides.

Alloyed Cast Iron

THE INTERNATIONAL NICKEL COMPANY, INC.

THROUGH the courtesy of the Development and Research Division, The International Nickel Company, Inc., it is possible to present an abstract of a review entitled "Recent Progress in Alloyed Cast Iron."

Efforts to introduce alloys into cast iron, begun about twenty years ago, were at first largely confined to foundries manufacturing rolls. The war stopped experimental and development work, in favor of production, but interest, particularly in the transportation industries, was revived after the war. While ten years ago the amount of alloyed cast iron was practically negligible, today, out of 17,000,000 tons of cast iron produced in 1937, approximately 10 per cent of it was alloyed. Improvement has taken place principally in melting practice, alloying, and heat-treatment.

Most of the alloys refine the graphite structure of cast iron, and most also build up the combined carbon content. Silicon is the exception to this rule. Vanadium and chromium stabilize the carbides and induce chilling effects. Nickel and copper refine the graphite and harden the matrix of the metal. Molybdenum and chromium, as well as vanadium, exert graphite refining tendencies. Practically all of the common alloys tend to promote uniformity in the structure and hardness of castings in heavy section. In addition to nickel, chromium, molybdenum, and vanadium in use today, titanium, zirconium, and possibly tungsten are coming into use. Other alloys studied include aluminum, antimony, arsenic, boron, bismuth, calcium, tin, and lead. Alloys may be added singly to a cast-iron heat to achieve some specific purpose, or may be introduced by pig irons, or added in concentrated form at the cupola spout.

Strength, toughness, and hardness of cast irons can be considerably improved by quenching and tempering treatment similar to that used for alloyed steels. Low-silicon and low-carbon types of cast iron properly alloyed respond best. It is possible to increase strength by 20,000 to 25,000 lb per sq in. in a properly alloyed cast iron. An important reason for heat-treating cast irons is to build up their structure and hardness to improve resistance to wear. Cylinder liners of heat-treated iron achieve a hardness on quenching exceeding 500 Brinell, and after tempering deliver in service approximately three times the mileage obtained from unheat-treated but alloyed cast iron. Another important function of heat-treatment is to increase the hardness of heavy sections.

The most spectacular result of progress in cast-iron metallurgy is the achievement of high strengths and by a combination of processing, alloying, and, in some cases, heat-treatment to develop high strength, stiffness; hardness, density, and uniformity, all in a single product. Twenty years ago the best tensile strength was at 24,000 lb per sq in. During the War the French produced irons of 40,000 lb per sq in., tensile strength; and in the United States 30,000, 35,000, and 40,000 lb per sq in. were attained. Up to 1922 effort was expended on the influence of ordinary elements in cast iron upon its strength.

The theory that cast iron consists of a steel structure slit with graphite flakes was recognized and efforts were expended toward reducing the slitting, thus building the cast-iron strengths up to steel levels as nearly as possible. It was thought that 50 to 60 per cent of the strength of steel might be attained if the graphite content could be controlled, so that it was relatively low and well-dispersed. A procedure developed by F. B. Coyle recognized the principle that if low carbon is to be obtained, increasing amounts of steel must be used in cupola charges. If graphite is to be fine and well-dispersed, a moderately acting graphitizer, powerful and positive in its effects, must be added. Other details indicated that these additions should be made to the liquid iron containing all of its carbon in the dissolved or combined form as it left the melting furnace, after which graphitizers were to be added while the iron was en route to the ladle. Coyle's work showed that 50 to 60 per cent of high carbon steel strength can be obtained in a plain iron by high-test alloy practice, and further improvements are in sight.

High-test nickel-alloyed cast irons can be adjusted to pour light and heavy sections with strengths well over 70,000 lb per sq in. Other advantages are also obtained. Stiffness, or modulus of elasticity, is greater and increases in proportion to increase in tensile strength. By heat-treatment an iron of tensile strength 60,000 lb per sq in. can be built up to a strength of 80,000 lb per sq in. It is important to temper after oil quenching to relieve quenching strains and finish with a hardness somewhat greater than that prevailing in the same iron as cast. However, it is said that heat-treatment of such irons is not progressing rapidly today, partly because of the desire of foundrymen to produce as high a tensile strength in the "as-cast" parts and eliminate heat-treating risk, such as cracking and distortion. Sensitivity to changes in section is also lessened in high-test alloyed cast irons.

High-test cupola irons show a relative indifference to notch effects obtained in fatigue tests where the notched bars of cast iron possess some 10 per cent less fatigue strength than bars of the same composition unnotched. The damping capacity is maintained and the modulus improved while the total carbon content is decreased. Also, it is said, the ultimate torsional strength is greater than the ultimate tensile strength.

The review concludes with the following statement:

The ultimate application of some of these principles is commercially represented in castings of the camshaft and crankshaft type which in themselves may require adjustments to the high-

test composition to produce additional properties characteristic of cast iron. For instance, the ability to produce a chilled tip on a cast iron may find the composition useful for cams even though this objective is achieved at some sacrifice in torsional or fatigue strength. The object of obtaining depth hardness on the iron surface or a high degree of machinability or castability in crankshafts may involve sacrifices in the stress-resisting properties, such as tensile strength, fatigue strength, torsional strength, and impact strength. It therefore becomes important for engineers, foundrymen, and metallurgists to analyze the stress-resisting requirements of their machines, to make such adjustments favoring good practice in the foundry and shops as represented by pouring quality, foundry handling factors, microstructure, machinability, and other less measurable factors, and then to compose these items into their designs to utilize the benefits made possible through the availability of these high-test irons. This cooperation between the engineers, metallurgists, and foundrymen in arriving at a suitable balance of these strength properties coincident with compositions properly balanced to permit easy processing in the foundry is an essential element in the further advancement of the high-test alloyed irons.

Scrap Metals

NATIONAL ASSOCIATION OF WASTE MATERIAL DEALERS

A GENERATION or two ago dire predictions were made as to the evil consequences of too rapid exhaustion of the country's mineral deposits. Today, we are well aware of the remarkable contributions made in later years by technology and the further contributions by geology, engineering, and metallurgy in extending the useful life of our mineral resources. Another resource which has proved valuable is the stock of metal in use, according to a paper delivered by E. W. Pehrson, assistant chief of the metal economics division, U. S. Bureau of Mines, at the twenty-fifth annual meeting of the National Association of Waste Material Dealers in New York City, March 15, 1938. A résumé of the paper follows:

Fortunately, except for a few metals, such as zinc and tin, only a relatively small part is used so that it can never be reclaimed. From a theoretical point of view it would be desirable to curtail such uses, but since the object of mineral exploitation is to provide for man's comfort and well-being, such curtailment would be inconsistent with a more practical attitude toward conservation. Obviously, therefore, the only real conservation that can be achieved in the utilization of metals is to promote constant use and re-use of that part of the production which goes into the nondissipative uses.

It is in this field that the scrap-metal industry is performing a valuable service that can be measured in a tangible way. For many years the U. S. Bureau of Mines has been collecting statistics on the use of scrap metals. The record shows that from 1907 to 1936, inclusive, approximately 9,000,000 tons of copper, 5,000,000 tons of lead, 3,500,000 tons of zinc, 635,000 tons of tin, and 682,000 tons of aluminum have been reclaimed from various cycles of use. These tonnages have added many years of life to the primary sources of supply, and for this reason there can be no doubt that they represent a major contribution to conservation. It should be mentioned in passing that the industry which has made this possible has grown to billion-dollar proportions as a result of natural economic laws.

Heretofore, there have been few, if any, statutory restrictions on the use in the United States and flow of metals to other countries. In foreign countries, however, such restrictions have been in vogue for some time, and exportation of scrap derived from deficiency minerals is now prohibited in many countries. Within the last few years there has been agitation for similar action in the United States, presumably to promote the interests of national defense, conservation, and employment. For minerals or metals of which there is an abundant domestic supply the value of trade restrictions is questionable unless it can be shown that exports constitute a real threat.

In a discussion of the fundamental aspects of the present iron and steel export situation, the author says that foreign shipments of iron and steel scrap have increased from 228,000 long tons in 1932 to more than 4,000,000 tons in 1937. Obviously, prolonged exports of this magnitude would deplete the reservoir of scrap available in this country and would hasten the exhaustion of the deposits of iron ore. It appears, however, that the present exaggerated demand for steel in foreign countries is temporary and will hardly endure for more than a few years. As a matter of fact, some of the principal foreign consumers of scrap already have taken steps to make themselves less dependent on distant supplies of iron.

Courtesy A. John, Junior Mem. A.S.M.E

SCRAP

The reservoir of iron in use in this country, from which the annual scrap supply is withdrawn, is enormous. Estimates have placed the amount at 750,000,000 to 1,000,000,000 long tons. There are no data on the rate at which this metal becomes available as scrap, but it is significant to note that the peak exports of 1937 amounted to only one half of 1 per cent of the total reserves of potential scrap. Moreover, the amount of metal added to the reservoir in that year was considerably more than that withdrawn. It may be conservatively estimated that in 1937, 35,000,000 tons of iron and steel products were added to the store of metal in use, whereas the total scrap withdrawn for domestic consumption

and for export probably did not exceed 25,000,000 tons. In other words, the reservoir of potential scrap was actually increased by 10,000,000 tons.

Higher prices, resulting in part from the export trade, have made possible the reclamation of large tonnages of material that under ordinary circumstances would have been dissipated as rust. A substantial part of the material exported has been of inferior grade, unsuited to the needs of domestic consumers, and probably never would have been reclaimed for domestic use at any price. To these ends, at least, exports actually have served the interests of conservation.

Two of the largest importers, Japan and Italy, are notoriously deficient in raw materials for steel manufacture. Their steel industry, therefore, is quite dependent on imports of scrap obtained principally from the United States. In 1937, Japan produced roughly 5,500,000 tons of steel. In the manufacture of this tonnage, more than 2,000,000 tons of scrap were used, of which the United States supplied 1,900,000 tons, or about one third of the total tonnage. It can readily be seen that sudden stoppage of this flow would adversely affect Japan's ability to produce steel. Recognizing their vulnerable position, especially from a military viewpoint, these nations are attempting to improve their condition and are succeeding to a surprising extent. Japan is importing increasing amounts of iron ore from nearby Asiatic areas, particularly from the Philippines. Italy, likewise, is becoming less dependent on foreign raw materials through improvements in technology and a broad self-sufficiency program.

The net effect so far of the increase in exports of scrap iron and steel has been an increase in employment. Higher prices have stimulated the collection of waste materials; as a result, record tonnages have been accumulated, sorted, and transported from all parts of the country. If the heavy foreign sales of scrap have created a shortage in the domestic supply and force consumers to use more pig iron, additional employment must have resulted, because the manufacture of one ton of pig iron requires the mining and transportation of two to three tons of iron ore, one and one-half tons of coal, and half a ton of flux.

Thus for every ton of scrap exported three to four tons of raw materials would have to be mined and smelted. Obviously, more workers would be required to produce and process over three tons of mineral raw materials than to produce one ton of scrap.

Direct-Drive Diesel Locomotive

ENGINEERING

A PRACTICABLE direct-drive Diesel locomotive, built by Humboldt-Deutzmotoren A. G., Germany, was described by Oberingenieur Dr. Finsterwalder at a meeting of the Institution of Mechanical Engineers in London, Jan. 17, 1938. A report of the talk, with explanatory illustrations and indicator diagrams, is given in *Engineering*, Mar. 4, 1938. Parts of the paper are presented in what follows.

Describing the layout of the locomotive by reference to the diagrams reproduced in Fig. 1, Doctor Finsterwalder pointed out that the motion arrangement of a three-cylinder steam locomotive had been adopted, the front driving axle being driven by the middle cylinder and the rear driving axle by the two outside cylinders. The double-acting cylinders are of 14.96 in. bore by 23.62 in. stroke, and have a port-scavenging arrangement similar to the Schnuerle type. Water cooling under pressure is employed. The scavenging air is supplied

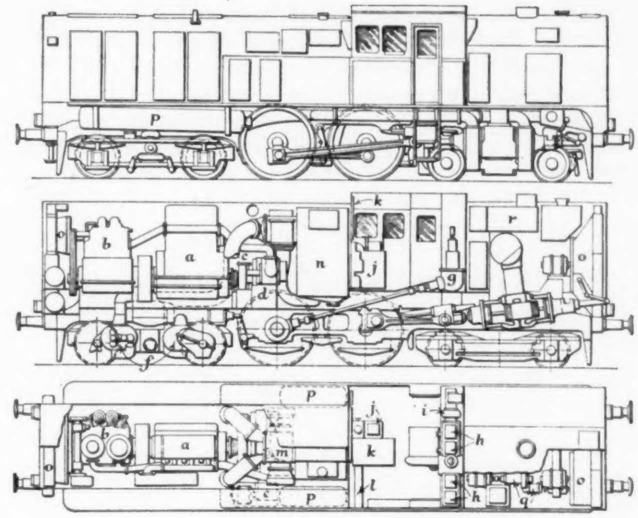


FIG. 1 THE HUMBOLDT-DEUTZ DIRECT-DRIVE DIESEL LOCOMOTIVE

(*a*, auxiliary engine; *b*, air compressor; *c*, generator; *d*, supercharger; *e*, auxiliary scavenging blower; *f*, main scavenging blowers; *g*, camshaft; *h*, fuel pumps; *i*, oil-operated control for supplementary air; *j*, control panel; *k*, instrument panel; *l*, switch panel; *m*, change-over valve for scavenging air; *n*, fuel tank; *o*, radiators and fans; *p*, air tanks; *q*, cooling-water pump; *r*, exhaust silencer.)

by two Roots blowers provided with a change-over valve permitting a change in the direction of running.

At speeds below 50 mph, the scavenging pressure is augmented by an electrically driven auxiliary blower. The compressed air is provided by a three-stage, two-cylinder, high-pressure compressor of 150 hp input, driven by a three-cylinder, four-stroke-cycle engine of 225 hp fitted with a supercharger. A 50-kw generator, driven by the same engine, supplies current to drive the auxiliary blower. Six air tanks of 78 cu ft capacity are provided. The driving wheels are 68.90 in. in diameter.

In railway service the torque, or tractive effort, should increase with decreasing speed, so that some method of augmenting the mean effective pressure of the engine at low speeds is necessary if direct drive is to be used. In the Humboldt-Deutz locomotive this is accomplished by introducing high-pressure air into the cylinder during combustion. The auxiliary engine drives the compressor at constant delivery so that with decreasing speed of the main engine, each stroke obtains a larger proportion of compressed air, the mean effective pressure consequently rising.

In order to secure greater tractive effort at starting, the locomotive is provided with air tanks which carry a supplementary compressed-air supply. The capacity of the tanks is enough to start a train of the maximum weight that may be hauled continuously, while at the same time they can be charged by the compressor pump in five minutes.

The fact that the engine works under compression tends to facilitate ignition, but to insure this at low speeds associated with starting, electrically heated glass coils of Micotherm are used. These have considerable heat capacity and are not unduly cooled by the starting air. To insure proper atomization of the fuel at starting, a vortex nozzle, working under an ignition pressure of 80 atm, is fitted. This arrangement is supplemented by a second high-pressure starting fuel pump supplying normal high-pressure nozzles.

The proportion of the power supplied by the compressed

air, the starting fuel and the normal Diesel fuel under conditions of starting, accelerating, accelerating on a gradient, and normal running on the level, are indicated in Fig. 2, together with associated indicator diagrams. Because too early introduction of compressed air would cause an excessively high ignition pressure, the air is admitted slightly after the dead center. After some adjustments of the fuel pump and the ignition, it has been found possible to make the locomotive run almost as smoothly as a steam locomotive.

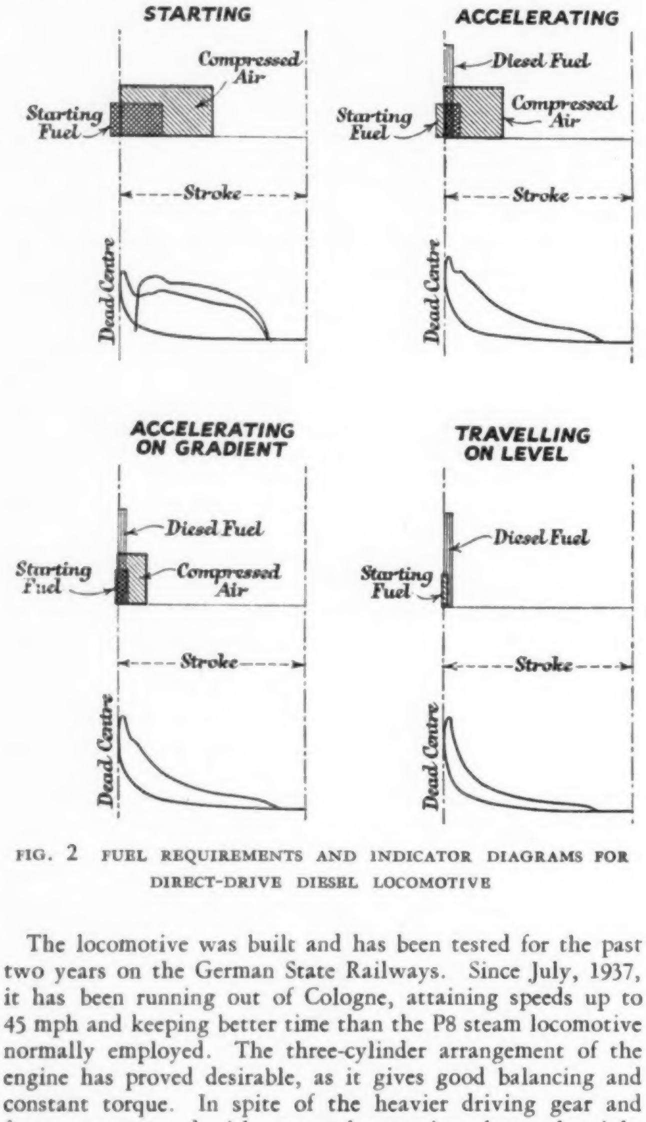


FIG. 2 FUEL REQUIREMENTS AND INDICATOR DIAGRAMS FOR DIRECT-DRIVE DIESEL LOCOMOTIVE

The locomotive was built and has been tested for the past two years on the German State Railways. Since July, 1937, it has been running out of Cologne, attaining speeds up to 45 mph and keeping better time than the P8 steam locomotive normally employed. The three-cylinder arrangement of the engine has proved desirable, as it gives good balancing and constant torque. In spite of the heavier driving gear and frame, as compared with a steam locomotive, the total weight of the direct-driven Diesel locomotive is lower, in this particular case amounting to 192,000 lb of which 79,000 lb is suitable for adhesion. This weight includes 5000 lb of fuel. Examination of the driving gear has shown little wear on the crankpins and axle boxes while the connecting-rod bearings remained in better condition than those of a stationary Diesel engine.

It has not been possible to make systematic dynamometer-car tests of the locomotive, but random tests have shown a fuel consumption of 4 to 5 grams per gross ton-kilometer (approximately 0.21 to 0.26 oz per ton-mile). The specific consumption with a partial train load of 220 tons has been established as 14.11 oz per drawbar hp-hr.

Exhaust Turbocompressor

MARINE ENGINEERING AND SHIPPING REVIEW

MEANS for increasing the economy of the marine reciprocating steam engine are briefly described by John W. Lewis in the March, 1938, issue of *Marine Engineering and Shipping Review*. Among several of these is reported the use of an exhaust-steam turbine, mounted directly on the condenser, and driving a turbocompressor which receives the exhaust steam from the high-pressure cylinder of a triple-expansion steam engine, compresses and reheats this steam, and passes it on to the intermediate cylinder for further expansion in the main engine. The exhaust-steam turbine thus does not deliver its power directly and by mechanical means to the main propeller shaft, nor to an independent propeller shaft, as in some other applications of this combined reciprocating engine and turbine drive.

Both in theory and practice this scheme is said to have proved eminently successful. In the case of the *Maplewood* the turbocompressor reduced the steam rate from 13.01 to 10.91 lb light and from 12.57 to 10.81 lb loaded. In the case of the *Beldagny* the coal rate after adding the turbocompressor came down from 1.448 to 1.036 lb per hp-hr.

Fuels of Today and Tomorrow

AMERICAN SOCIETY FOR TESTING MATERIALS

FUELS in various forms are used by railroads, ships, motor vehicles, airplanes, public utilities, industries, and in the home. A. C. Fieldner, chief of the technologic branch, U. S. Bureau of Mines, in a paper presented as his presidential address before the American Society for Testing Materials, June 28, 1937, and subsequently repeated by him before other engineering and scientific bodies, including several local sections of the A.S.M.E., reviews the changing conditions of fuel supply and demand during the last 30 years.

With this introduction, Fieldner, in considering the present situation, states that we have solid, liquid, and gaseous fuels in abundance, and we are using them at an increasing rate. The total energy supply from these mineral fuels, in trillions of Btu's, increased from 14,000 in 1907 to 24,600 in 1929; a 75 per cent increase in 22 years. The depression caused a drop to 16,122, but recovery had raised the figure to 21,878 by 1936.

In round numbers, industry and public-utility power consumed 45 per cent, transportation about a third, and domestic and miscellaneous uses one fourth of our energy supply. Coal constituted 84 per cent of the fuel for domestic and miscellaneous purposes, 73 per cent for industrial use and public-utility power, and 57 per cent for transportation; petroleum provided 43 per cent of transportation fuel, including almost 100 per cent of road-vehicle and airplane fuel, 73 per cent of marine fuel, and 11 per cent of railroad fuel. Natural gas comprised 16 per cent of industrial and public-utility fuel consumption and 7 per cent of the domestic and miscellaneous needs. Since 1929, 7 per cent of the total energy demand has been transferred from anthracite and bituminous coal to petroleum, natural gas, and water power. The continuation of this shift concerns not only the operators and workers in the coal and oil industries, but the nation itself with respect to future needs.

During 1936 we produced and consumed 31 to 33 per cent of the world's production of coal, 60 to 70 per cent of the petroleum, and 95 per cent of the natural gas. We have a little more than

one half (3.2 trillion tons of coal and lignite) of the world's reserves of coal, and probably 60 per cent of the proved oil reserves. Two thirds of the oil produced in all countries since the discovery well was drilled in 1859 has come from American wells. The most recent estimate of the proved oil reserves in the ground recoverable by the current methods of production is put at 13 billion barrels.

There is coal enough for hundreds and possibly thousands of years; but natural gas and oil obtainable by present methods may be exhausted in less than 100 years, and a shortage of our domestic supply may begin within 10 or 20 years. How shall we meet this situation, and what will be the fuels of tomorrow? An appraisal of present trends and future probabilities indicates an answer to this question.

Coal will continue to be the principal fuel used for the generation of public-utility and major industrial power. Technological improvements and new hydroelectric power will tend to reduce the consumption of coal; on the other hand, an increasing demand for energy and a decreasing supply of cheap residual oil will increase the amount of coal consumed for power purposes. Tomorrow's power and central heating plant will burn any kind of coal completely and efficiently. There will be no smoke, no dust, and no sulphurous gases emitted to the atmosphere.

No substitute has appeared for metallurgical coke. The coke-oven industry will expand and consume more coal in accordance with metallurgical needs, which are greatly affected by the supply of iron and steel scrap, but relatively few new installations for gas production can be expected in the near future on account of the availability of natural gas. As natural gas approaches exhaustion, gas from coal will take its place.

The convenience and uniformity of automatic heating of homes with gas or oil will continue to attract more users, even at higher costs than those prevailing today. The insulation of houses has been greatly improved, and future homes will permit higher unit cost of fuel without increasing the total heating bill. On the whole, coal, because it is the cheapest fuel, will continue to contribute the major portion of the fuel used for house-heating and miscellaneous manufacturing, although further displacement by oil and natural gas will follow in the next few years.

In 1929, 88 per cent of the railroad fuel was coal; since then Diesel locomotives have been adopted by several railroads for lightweight, high-speed passenger trains; an increase in Diesels for such service is expected, but no general change from steam to Diesel power is likely to take place.

Marine transportation is energized by oil. Approximately three fourths of the marine fuel used in 1936 was oil, and 40 per cent of this oil was used in Diesel engines. This trend will continue. The convenience and economy of Diesel-engine drive for ships is such that its use will continue even after declining production of petroleum requires the production of Diesel fuel from shale or coal.

From the very beginning of the automobile industry, recurring threats of shortage of gasoline were met—in the field, by finding new pools and improving production technique, and in the refinery, by increasing yields and making a more efficient product. The end has not been reached. We are just beginning to use scientific methods in extracting oil from the sands, and polymerization and hydrogenation eventually will furnish the means for complete conversion of volatile liquids and heavy petroleum to gasoline. These improvements, and others yet to come, will add their bit to extending our petroleum reserves. As demand exceeds supply and prices rise, supplemental fuels of similar characteristics from other sources will come in. These sources are coal, oil shale, and vegetable materials.

Our gas, oil, and coal have energized an industrial civilization on a magnificent scale. Scientists, engineers, and an enterprising business organization have modified these materials to meet our every need; and finally, we are awakening to the need of conserving these resources wisely so that the generations of tomorrow will have better fuels than we of today. Future scientists may unlock undreamed of powers, but we as engineers should plan on the basis of the resources known today.

Port Washington Performance

COMBUSTION

Power engineers watch with interest the performance records coming from the Port Washington plant of the Milwaukee Electric Railway and Light Company. The first year's operation of this plant was reported in the November, 1936, issue of Mechanical Engineering in a paper by F. L. Dornbrook. In *Combustion* for February, 1938, the record is brought up to date by M. K. Drewry, member, A.S.M.E.

The Port Washington plant, it will be recalled, is a reheat plant consisting of a single 690,000-lb bent-tube boiler and an 80,000-kw tandem compound turbine generator operating at 1300 lb per sq in., 825 F steam temperature. To date it has operated 86 per cent of the time since the month of "tune up," November, 1935, with an availability of 88.7 per cent. The first year's average heat consumption was 10,954 Btu per net kwhr; for 1937 this figure was slightly reduced to 10,835.

U. S. Power Statistics

PROCEEDINGS, AMERICAN SOCIETY OF CIVIL ENGINEERS

Statistics on the total horsepower of prime movers in the United States are frequently sought for by engineers, and a convenient table, prepared by A. A. Potter in the Report of the National Resources Committee, is quoted by Geo. A. Orrok in a paper "Progress in the Generation of Power by Heat Engines," to be found in *Proceedings*, American Society of Civil Engineers, December, 1937. Dean Potter's estimates, as of June, 1936, are as follows:

	Horsepower
Electric central stations	44,670,000
Industrial power plants	20,133,000
Electric railway plants	2,500,000
Isolated nonindustrial plants	1,500,000
Mines and quarries	2,750,000
Agricultural prime movers	72,763,000
Automotive	965,000,000
Airplanes	3,500,000
Locomotives	88,000,000
Marine	30,000,000
Total	1,230,816,000

Of the stationary power plants, except those credited to transportation, Dean Potter scheduled 56,684,000 hp in steam plants, 16,075,000 hp in water-power plants, and about 2,000,000 hp in oil and gas-engine plants.

When it comes to actual horsepower-hours, Mr. Orrok points out, the figures are a little uncertain. However, he says, it is probable that the 1935 output of steam and water-power plants alone was not far from the equivalent of 142,000,-

000,000 kwhr, of which more than 100,000,000,000 kwhr was generated by steam. The average per capita use of power, central-station and industrial, is thus in the order of 1115 kwhr per yr. The equivalent kilowatthours of transportation power, locomotive plus automotive, is estimated conservatively at 150,000,000,000 kwhr, making a total per capita use equivalent to 2300 kwhr per yr.

Confining his attention to 56,680,000 hp in steam plants, Mr. Orrok estimates the average annual use at about 1730 hr, making the total annual output of steam plants roughly 98,000,000,000 kwhr. The central-station output of 55,000,000,000 kwhr is generated at an expenditure of about 1.45 lb of coal per kwhr, while the industrial output of 43,000,000,000 kwhr requires not far from 3 lb of coal per kwhr. The average use for both classes of plants is 2.13 lb per kwhr, or the equivalent of 104,000,000 tons of coal per yr, roughly 20 to 25 per cent of the annual coal output of the country.

Resins for Feedwater Treatment

CHEMICAL RESEARCH LABORATORY (GREAT BRITAIN)

ACCORDING to a report received from the Chemical Research Laboratory, Teddington, England, B. A. Adams and E. L. Holmes have carried out thousands of experiments in studying the possibility of removing acids, bases, and salts from solutions by synthetic resins. They have found that various cations, including aluminum, antimony, arsenic, ammonium, calcium, iron, potassium, sodium, tin, and zinc, and dissolved gases and microorganisms, can be removed from solutions of their compounds by passing the water through powdered resins of the bakelite and other types.

Chemists are familiar with the fact that certain resins have pronounced and selective adsorptive properties, and, as some of these may be prepared economically, their application to the purification of solutions and to the extraction of dissolved substances is practicable. After the powdered resins can absorb no more impurities, they can be regenerated by treatment with solutions of acids, such as hydrochloric acid, or of certain salts. Exchange of cations with some of the phenolic resins appears to be selective in character, while with other resins of the same type the exchange is similar to that of base-exchange zeolites used in water softening. It is also possible to utilize the acid-calcium exchange, in which case the filtrate would contain free acids and no dissolved salts. Water of this nature might be advantageous in some industries.

Since the resins remove completely both alkalies and carbonates from a solution, they may be used for the removal of lime in the "excess-lime" process of water purification and for the removal of the excess of lime and sodium carbonate, as well as the last traces of calcium and magnesium, in a lime-soda-softened water. It is stated that the removal of ammonia and ammonium salts from boiler feedwater, and of iron, manganese, lead, copper, zinc, or other objectionable impurities from drinking water, can also be effected by use of synthetic resins.

By the consecutive use of phenolic and amino resins it is possible to effect complete removal of dissolved salts from solutions, yielding a filtrate equivalent to distilled water. In some cases, water may be encountered having too high a saline content to allow complete removal in one operation. However, repetition of the process will produce the required result. It is evident that if this process can be perfected commercially, it could be utilized for the treatment of boiler feedwater, as well as for the purification of sea water and sewage.

Revolving-Cylinder Engine

THE SHIPBUILDER AND MARINE ENGINE-BUILDER

OPERATING on a principle hitherto relatively unknown, a steam engine of the revolving-cylinder type has been developed by two English engineers, J. G. Edmundson and J. B. Taylor. A description of the construction, principle of operation, and operating characteristics is given in an article in *The Shipbuilder and Marine Engine-Builder* for February, 1938.

Referring to Fig. 3, two rotors (1 and 2), with their axes at right angles, are mounted on ball bearings (3), carried on the base plate (4). These ball bearings also act as thrust bearings. Each rotor has six longitudinal bores of equal diameter, spaced regularly about the center line. Fitting into these 12 bores, which act as cylindrical guides, are six cylinders (5_1, 5_2, etc.), each having two barrels with their axes at right angles.

Bolted to the rotor is the cover (6), to which are rigidly attached six pistons (7_1, 7_2, etc.). Piston rings fitted on floating pistons insure gastight seals. An internal passage from each piston crown through the rod is provided, leading to a corresponding port in the cover (6). The piston assembly (10_1, 10_2, etc.) attached to the cover (9), which is bolted to the rotor (2), is similar, except that no internal passages are provided in the pistons. The driving shaft (11) is integral with the cover (9).

The block (8) is bolted to the fixed framework (4). Inside

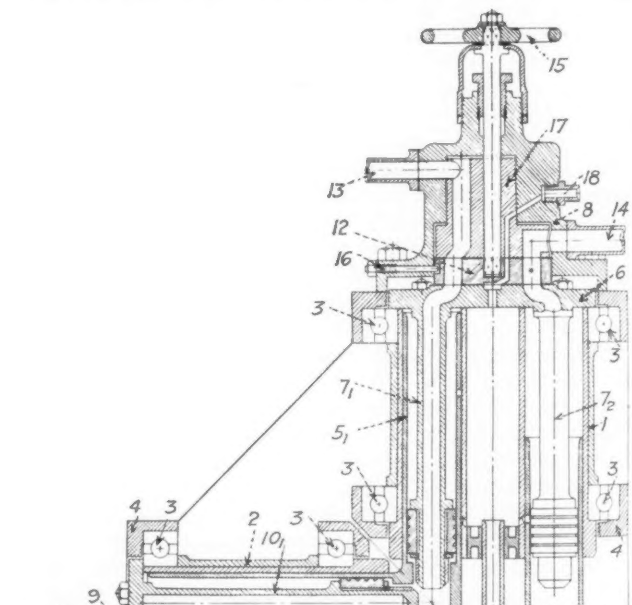


FIG. 3 ARRANGEMENT OF THE EDMUNDSON-TAYLOR ROTOR ENGINE

the block, and bearing on the upper face of the cover (6), is a disk valve (12) which controls the sequence of operations for all cylinders through the inlet port (13) and the exhaust port (14). The handwheel (15) rotates the disk valve through a set angle, thereby causing rotation in the opposite direction. Another feature is the balance piston (17), which presses the disk valve onto the cover by means of the inlet pressure acting on its top surface. Provision has been made for lubrication by introducing oil through the passage (18) to the central space, from which a portion is passed through holes to the external and internal surfaces of the cylinders, while the remainder overflows through the angular pipe (19) to lubricate the cylinders of the rotor (2) in a similar manner.

The engine described is a 12-hp unit of the multicylinder, two-stroke-cycle, opposed-piston type. Referring again to Fig. 3, one cylinder (denoted by the suffix $_1$) is at the inner dead center, and the other (suffix $_2$) at the outer dead center. At the inner dead center steam is admitted to the working space. There are then two resultant unbalanced forces, each of a magnitude equal to the piston area times the fluid pressure. These forces act in directions parallel to the cylinder axes and are transmitted through the cylinders to the rotors, thus causing rotation. At a predetermined angular displacement, cutoff occurs, and the steam expands (due to the increasing space between the piston heads) until the outer-dead-center position is reached and release takes place. Cushioning is unnecessary, as no heavy reciprocating parts have to be brought to rest.

Attention is drawn to the small number of working parts of this engine, there being only eight in the six-cylinder model. From the manufacturing viewpoint, these engines should be inexpensive to produce, as practically the whole of the machining consists of boring and turning. Further, the duplication of many of the component parts lends itself to economical manufacture. After 1200 hours of running under load, the 12-hp engine was dismantled and checked with a micrometer. No wear could be detected. The machining and grinding marks were still showing on the outer surfaces of the cylinders; while on the inside, bright marks from the rubbing of the piston rings could be detected, but no wear. The faced joint between the disk valve and balance piston was also still in perfect condition. The engine has now run for over 1400 hours and shows no loss of efficiency or power.

Pipe Bends as Flow Meters

ENGINEERING

RECOGNIZING that there should be a direct relationship between the differential pressure head across a pipe bend and the discharge of water flowing through the bend, Herbert Addison, in *Engineering*, March 4, 1938, develops the hydraulic theory involved and reports experiments on such a relationship in a paper that is entitled "The Use of Pipe Bends as Flow Meters."

The author discovered that the curvature ratio of the bend, i.e., radius of bend to radius of pipe, seems to have a positive influence on the coefficient of discharge through the bend, there being apparently a breakdown of true vortex flow as the value of the ratio reaches 2. Should such a relationship as he found between this ratio and the coefficient of discharge be supplemented by further records, he is of the opinion that the flow through any uncalibrated bend could be roughly gaged with an error of not much more than ± 5 per cent; and the measurement would, in any event, give quite reliable guidance concerning the relative flow in the pipe. Thus, he says, a pump user who had made a single differential-head reading on a bend in the delivery pipe could tell at a later date whether or not the pump was holding its output.

The suitability of a pipe bend as a precision meter, he points out, depends on the means available for calibrating it. If a single rate of flow could be accurately gaged by some other device, the bend could thereafter be used as a meter with a probable error of ± 2 or 3 per cent; while if three points on the calibration curve, spaced well apart, could be established, then the bend should be as reliable as a venturi meter.

The most attractive feature of bends when used as water meters is naturally that they involve no additions or important alterations to an existing pipe system, thus entailing no additional expense and no additional loss in head. They cannot be recommended, however, if the mean velocity in the pipe is much less than 4 fps. Neither should a sharp bend, with a curvature ratio less than 2.5 be used, if it can be avoided.

Design of Steel Castings

AMERICAN FOUNDRYMEN'S ASSOCIATION

A BOOKLET, entitled, "The Influence of Design on the Stress Resistance of Steel Castings," written by R. A. Bull and completed shortly before his death on July 29, 1937, has just been published by the American Foundrymen's Association. In its 62 pages, Major Bull has assembled and evaluated such semitechnical, essentially practical information on the subject as might be widely helpful, especially to those engineers who have had limited opportunity to familiarize themselves with the manner in which certain phenomena occur during steel casting, and the way in which these phenomena are influenced by the proportions of the piece made.

The theme of the treatise is aptly expressed in the two basic principles of steel-casting design. Tersely expressed, these principles call for the nearest feasible approach to uniformity in cross section, and for liberally filleted member junctions. Of course, there are other principles that need to be observed; but the two mentioned are the most important in the author's opinion.

Major Bull claims that some engineers in their steel-casting proportions are still influenced by old gray-iron designing practice The chemical composition of ordinary steel requires a lower content of carbon than that found in cast iron. This causes steel to shrink or contract from the liquid state to the cold solid state to considerably greater extent than does the weaker metal. Furthermore, the smaller amount of carbon in steel necessitates a pouring temperature higher than that needed when pouring iron under similar conditions of mold shape, for supplying the required amount of fluidity.

The shrinkage or contraction of steel is usually considered to be $^1/_4$ in. per ft; provided that the shape of the mold cavity and the constructional features of the mold itself are not necessarily such as to set up considerable resistance to the steel part when, during, and immediately after solidification, it tries to contract and thereby follow natural laws. However, commercial experience discloses the fact that the measurable degree of contraction is extremely variable, being largely dependent on casting design.

It is well known that the crystalline structure of a piece of steel is regulated not merely by its chemical composition, but to a large extent by the time consumed for solidification and subsequent cooling within the mold. Consequently, at the junction of two members of widely varying thickness, there is not merely a difference in the plastic state and in the subse-

quently red-hot condition of nondestructive "stretchability," but a material difference in the size of the grains of which the structure of the steel is formed. Because the thick member cools slowly, its average grain size is relatively large. Naturally, this condition is more pronounced within the central portion of the member than near the skin or surface.

Heat-treatment (includes full annealing and normalizing, as well as more complicated procedure calling for two or more heatings) is used to relieve the cooling stresses set up by the solidification and the chilling of the steel casting within its mold. But a very massive casting that is subjected during heat-treatment to rapidly accelerated cooling on its surfaces may have some injurious cooling stresses developed in it. These are not experienced when a casting is formed wholly of thin or of moderately thick members; or even when the massive casting is so symmetrically designed as to have members of fairly comparable thickness throughout.

The sharp corner is a bad feature of any industrial metal part, whatever may be the kind of metal used, and whatever may be the method of production or fabrication; provided that considerable stress is apt at some time to be exerted from any direction toward that portion of the piece which is characterized by distinct angularity or by a very small fillet.

It is unnecessary that the dependable steel casting have comparable thicknesses in all its members if there is a symmetrical connection between those portions that are of unequal thickness and if liberal radii are used for all fillets at member junctions. Of course, the serviceability of any constructional part is determined largely by the intensity of mechanical stresses imposed and localized on the various members, the particular kinds of stresses exerted, and the directions from which the stresses come.

There are other troublesome factors besides those just described which may be influenced by an inferior design of the steel casting, partly dependent on the way it is to be molded. One of these comes into play when certain characteristics of the mold may be naturally conducive to small gas cavities or pores in the product. It is known to most engineers that molds for steel castings are made both of oven-baked sand and of green or undried sand. The green mold will generate more gases in pouring than will the baked mold of equivalent shape, because of the greater amount of moisture in the undried sand. A casting so shaped as to make it readily susceptible to rupture while hot has its best chance to shrink when the sand mold is in its most compressible condition; which often means, when the sand is green or undried. The skillful steel foundryman of today is able to control the formation and outlet of gases liberated within a mold.

Occasionally, there may be seen in the steel foundry a number of castings having considerable areas of heavy metal attached on all sides to members of much smaller thickness, so located as to have given the foundryman no opportunity properly to feed the heavy portion by means of a conveniently placed riser or sinkhead. If all members surrounding a heavy one are very thin, obviously they will not long carry feed metal to it from a remote massive portion, because of the relatively rapid solidification of the steel in the light connecting sections. This weakness of design may be lessened by using external or internal chills, to accelerate the freezing to the thick portion, and thereby develop in it a cooling rate more like that of adjacent members.

If the engineer will take the time to examine, with particular regard for the related metallurgical phenomena, a right-angled crossing of members of equal thickness (such as those frequently found in the reinforcing ribs under a plate), he will probably realize that the mere crossing of the members is bound to retard the cooling of the metal at that point. Anything that tends to retard solidification of a member at a point where connecting members freeze at a relatively rapid rate is certain to produce weakness, because of the temperature gradients that are developed.

When heavy flanges are placed externally at intermediate points, or when thick members are located internally (as for providing certain valve seats) it becomes difficult, and sometimes impossible, for the foundryman to provide helpful mold releases, which is the term for a readily compressible part of the mold or an open space in the mold, formed before or after pouring, intended to permit the contraction of the casting to greater extent than would otherwise be possible.

Sometimes it is advisable to lessen the relative massiveness of some members, instead of increasing the thickness of lighter ones. In many cases, a steel casting is more resistant to mechanical stresses if it is made lighter in weight. Such details as these influence the cost to the producer, and the price which the consumer has to pay. It is stating the obvious to point out that the cost factor should invariably be considered by the designing engineer who is properly appreciative of economic considerations.

Variable Spindle Drive

MACHINERY (LONDON)

A STEPLESSLY variable V-belt spindle drive, for which high tractive power, efficiency, and insensitiveness to sudden shock are claimed, is described in *Machinery* (London), March 17, 1938, as a feature of an Auerbach and Scheibe drilling machine exhibited at the Leipzig Fair. The essential features of the drive are shown in Fig. 4.

The drive consists of two pairs of coaxial cone-pulley members, two of which, *A* and *B*, are mounted on the driving shaft, the other two, *C* and *D*, being on the driven shaft. The pulley members can be adjusted toward and away from each other with a telescoping movement facilitated by openings in the pulley flanges through which corresponding spoke portions of the opposed members slide. Axial adjustments of movable members *A* and *C* are effected simultaneously by double-armed lever *E*. Speed changing, with stepless variations, is carried on while the machine is running by operating a lever which actuates arm *E* through a rack and pinion. A speed indicator shows the adjusted speed.

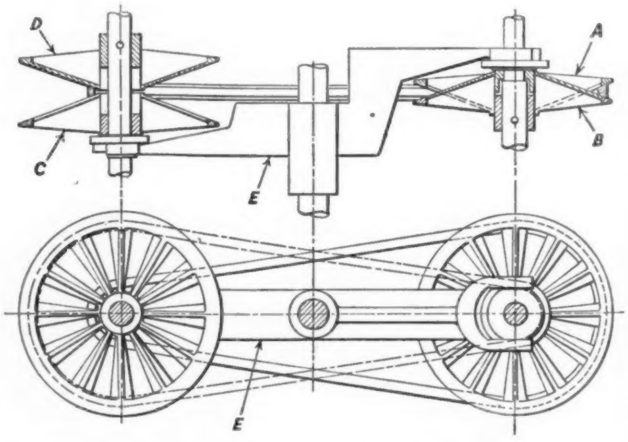


FIG. 4 STEPLESS SPINDLE-DRIVING MECHANISM

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Railroad Mechanical-Engineering Progress

To the Editor:

It has been my privilege to review a preprint of part I of Dr. Giesl's[1] report wherein he deals with "High-Speed Service and Steam-Locomotive Developments." Such reports invite little comment whenever the field has been adequately surveyed. Their scope will not permit any extended review of the equipment to which they refer, and, to that extent, they are not satisfying in themselves but, when supported by a complete bibliography, no good reason exists for one's failure to seek out the details that he should have in units of particular interest. We can, however, direct attention to certain elements that have been mentioned and appear to be deserving of far more space than can be devoted to them in the report. With my remarks predicated upon my study of the locomotive section alone, three such references appear to be outstanding in the far-reaching results that they imply. These are

(1) Removal of headend services from our best and fastest trains.

(2) Installed capacity of Diesel-locomotive power plants.

(3) Railway equipment benefits by examination of automotive processes in design.

Handling headend services on individual fast trains is an operating factor of the type with which the railway mechanical officer is too seldom concerned; not because he is unable to contribute sound reasoning in arriving at a well-considered conclusion, but his views are not solicited. When dealing with selected times of departure and arrival that demand high levels of scheduled speed, the railway mechanical engineer, more than any other man, appreciates the desirability of fitting this speed to conform, as nearly as possible, with the maximum speed to be attained. The next step is that of determining to what extent the fastest train can be utilized for purposes other than carrying passengers, without resulting in delay and further, what the engineer can do in equipment design to accelerate the exchange of passengers. It is inevitable that station time must be reduced by whatever means may be conceived by diligent study of the problem and without interference with the preferences of the passenger. We cannot foretell the ultimate scheme, the disposition of headend services is of relatively minor concern, but I can commend the problem to the serious consideration of every responsible man in the mechanical, traffic, and operating departments of our railways.

An obvious tendency has been to scrutinize the power-plant capacity that must be provided to permit compliance with a carefully studied and usually intensely exacting schedule and then to specify the minimum capacity that calculations show to be adequate. The cause can, of course, be readily attributed to the high unit cost of the Diesel engine and prevailing steam-locomotive practice. However, the steam locomotive is invariably more generously designed and is capable of working for prolonged intervals at power rates well beyond its rated capacity. We do not have data to establish definitely the maintenance-cost burden or the ultimate effect upon engine availability that power-plant selection upon such a basis may impose; but it is doubtful if anyone will question the desirability of affording high power output over limited periods and less pressing demands throughout a continuous run. We are acquainted with measures currently taken to preclude engine failure en route, oftentimes reinforced by provisions for prompt repair without benefit of terminal facilities. Such close relationship between power necessarily available and capacity installed seems scarcely defensible and we will, no doubt, witness more liberal ratios, encouraged by a sustained trend in lowering unit costs. It has never been found economically practicable to operate a power plant continuously at the peak of its output.

Railway equipment is evidencing, to ever greater degree, the influence of automotive practices in design, yet railway mechanical engineers are inclined to be reluctant to accept as such, many of the principles that are identified with automotive manufacture. In the automotive field, an industry has arisen without precedent. Any attempt to adopt the predominant design features of the only comparable mechanized-transport enterprise, the railways, would have immediately defeated the industry that has pioneered in materials, tolerances, machine-shop practices, and production methods. Much of automotive design can never be translated into the design of railway equipment to be used in train service, but can we doubt that many principles which have assisted in the phenomenal development of the automobile, bus, and truck, can be accepted with suitable modifications to the needs of railways and with like benefit? I should welcome constructive criticism from a competent automotive designer relative to railway locomotives and rolling stock. I am confident that we could benefit greatly.

L. K. Sillcox.[2]

[1] "Progress in Railroad Mechanical Engineering in 1937," report prepared by Railroad Division Committee on Survey (RR6), Mechanical Engineering, December, 1937, pp. 931–941.

[2] First Vice-President, New York Air Brake Company, Watertown, N. Y. Mem. A.S.M.E.

To the Editor:

The description of noteworthy passenger cars in the progress report[1] indicates clearly how the body structure having sides designed as load-carrying girders, which was almost universally used in this country until about three years ago, is now being varied by side-truss structures or by tubular bodies designed to act as unit load-carrying members. It appears that the comparative merits of the various types, or the field in which each is more satisfactory than the others, have not yet been determined.

An indication of the extent to which materials adapted for lightweight construction have superseded plain carbon steel is found in the fact that of the 471 passenger cars ordered in 1937, only about 100 have bodies constructed of plain steel. Stainless and high-tensile steels which have been used extensively in passenger equipment only during the last three years, were applied in four out of

five passenger cars ordered during the year 1937.

Low-alloy high-tensile steels are being used also in more than 5000 freight cars ordered the last year. Recent developments have shown that by proper design, lightweight boxcars built of these materials can be made to cost no more than conventional carbon-steel cars and to provide strength at least equal to the conventional designs.

The progress report mentions that extremely light designs of Cor-Ten hopper cars have been somewhat strengthened in recent orders. Information has been furnished the writer that the performance of lightweight cars up to this time indicates that the body sheets may be expected to last approximately as long as copper-steel sheets of standard thickness in the same service. Thus far, there has not been any indication of inadequate strength in the lightweight cars, and the heavier construction has been adopted in later designs to provide a range of construction to determine whether it is more economical to apply high-tensile corrosion-resisting steels, so as to achieve maximum reduction in weight and maximum saving in operating expense or to provide increased strength by a lesser weight reduction, thereby securing moderate operating savings together with some reduction in maintenance expenses.

A. F. STUBBING.[3]

TO THE EDITOR:

In view of the pertinent statement by Dr. A. Giesl-Gieslingen[1] that boiler capacity is often limited by water carry-over, the following remarks may be of interest. Few railroads have completely standardized on their locomotive-dome separator equipment, but the larger number of multistage driers indicates a general preference over the once-through single-stage types. To date 400 Dri-Steam locomotive separators and 600 Dri-Steam auxiliary or turret pipe separators are in regular service. Excellent results under road conditions are obtained because these separators offer the following advantages: (*a*) external deflection of water surges, (*b*) stratification of the steam into thin layers, (*c*) thorough scrubbing, (*d*) powerful inertia effects by flow reversals and combing the steam at high velocity through expanding nozzles, (*e*) instant removal of the separated water and solid matter from the steam path, (*f*) absence of spattering or misting effects inside of the separator, and (*g*) negligible pressure drop.

C. T. SCHREIBER.[4]

[3] Railroad Mechanical Engineer, United States Steel Corporation, New York, N. Y. Mem. A.S.M.E.

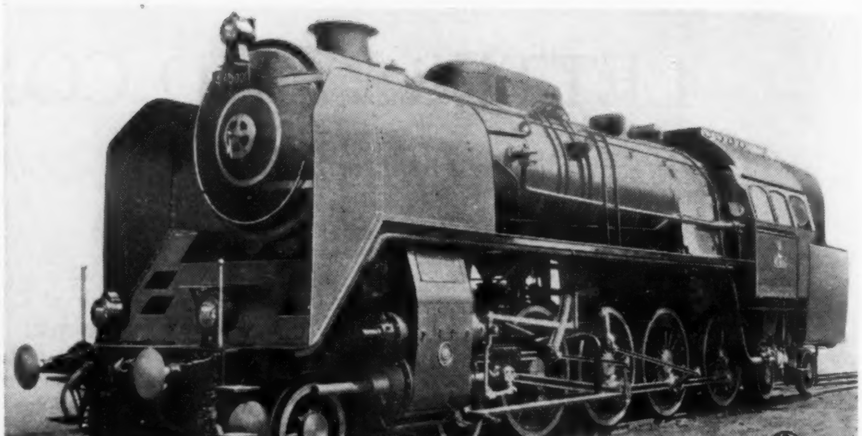


FIG. 1 EXPERIMENTAL THREE-CYLINDER TANK LOCOMOTIVE OF THE CZECHO-SLOVAKIAN STATE RAILWAYS

TO THE EDITOR:

The paper[1] is thorough and informative, gives a complete review of railroad mechanical progress in 1937, and is well-illustrated by photographs of the reviewed equipment. There are only two remarks which I could make.

First, in describing the European locomotives, no mention is made regarding the Le Maitre drafting arrangement of the French Nord Railway. In fact, Dr. Giesl-Gieslingen in his review of "Steam Locomotive Details" states, in reference to locomotives abroad, "No new developments appeared in boiler front ends." While the Le Maitre was experimentally tried out in 1936, it was only in 1937 that a great number of du Nord locomotives, more than one-half of all its modern power, was equipped with front ends of this type.

Likewise, no mention is made of the direct-driven Diesel locomotive developed by Humboldt-Deutzmotoren A. G., Köln-Deutz, Germany. Several years ago this firm built a Diesel locomotive[5] and succeeded in placing it in 1937 in regular service on one of the German railways between Köln and Cleve in passenger trains, with 24 stops and accelerations on a distance of 120 km. The locomotive, weighing 96 net tons, starts with a train of 242 tons under its own power, the fuel oil igniting in an atmosphere of compressed air almost at starting and the locomotive accelerating during the period of oil burning in a mixture of air from an outside source and internal Diesel process. Regular running, after the speed has reached 44 mph takes place according to a pure Diesel cycle. Indicator cards from the start resemble steam cards at cutoffs on a descending grade from 60 per cent down to 9 or 10 per cent of a Diesel card. The locomotive is of the 4-4-4 type, with a direct drive from the pistons in the horizontal locomotive cylinders to the main and coupled driving axles. All the difficulties of such a direct self-starting process without any transmission have been overcome in the fifteen years of development, and the locomotive is now in service.

One intrinsic difficulty in the design of the locomotive still remains. This is the large weight main rod for a comparatively small locomotive, due to the great pressures on the piston of a Diesel cylinder. On account of this, the application of the principle of this locomotive to large power for American conditions is rather doubtful.

A. I. LIPETZ.[6]

[4] Sales Engineer, Dri-Steam Valve Sales Corporation, New York, N. Y. Mem. A.S.M.E.

[5] "Progress in Railroad Mechanical Engineering in 1935," report prepared by Railroad Division Committee on Survey (RR6); also "Directly Driven Diesel Locomotive," *Railway Gazette*, Diesel Railway Traction Supplement, Jan. 26, 1934, pp. 160–161.

TO THE EDITOR:

The author is indebted to all who, by their comment and friendly criticism, have manifested a gratifying interest in this committee's work.

Referring to the remarks by Dr. Lipetz,

[6] Chief Consulting Engineer in Charge of Research, American Locomotive Company, Schenectady, N. Y. Mem. A.S.M.E.

the Le Maitre exhaust arrangement had been discussed extensively in the 1936 Progress Report; the statement in the present report is literally correct. Against the adoption of the Le Maitre device by the French Nord Railway in 1937 stands the omission, in the same year, of this device of the repeat order of the Class 1 high-speed Pacifics of the Belgian National Railways on which it had been tried in 1936. Thus, the trend is not clear at present.

Information on the recent successes of the Humboldt Diesel locomotive had been received too late, and Dr. Lipetz' account thereof is appreciated.

Mr. Stuebing appropriately points to the diverging types of body structure now manifest in passenger-car design; the committee regrets that sufficient information was not available to permit a typical presentation of the modes of construction, and this interesting subject may well receive attention in coming reports.

Mr. Schreiber's discussion is a welcome amplification of a subject on which this committee was not fully informed.

A communication from Czechoslovakia states that Fig. 14 of the report erroneously depicts a two-cylinder locomotive, of which 44 had been built since 1934. The experimental three-cylinder design, Class 475, referred to in the report is reproduced as Fig. 1, and should replace the illustration included in the report.

A. GIESL-GIESLINGEN.[7]

[7] Consulting Engineer, Brooklyn, N. Y. Mem. A.S.M.E.

Surface Finish

TO THE EDITOR:

The paper on "Surface Finish" by Mr. Way[8] provides a good survey on existing methods for testing the quality of machined surfaces. For instance, comparing two surfaces simultaneously under a microscope, the qualitative method, appears to be limited, in so far as only well-marked differences are easily observed. When both surfaces are of nearly equal quality, estimating the actual difference is, to a certain extent, a question of personal opinion. Comparison of a given surface with a standardized mirror and measuring the light reflected from both is most likely confined to laboratory practice and could not so easily be adapted to the requirements of industrial needs.

All methods registering roughness of a surface by passing a needle or diamond point across the ridges generally more or less destroy those ridges by cutting across them. At the same time, recording of the finest corrugations depends on the size of the needle or radius of the diamond point which cannot penetrate into grooves smaller than the point itself. If the shortest radius of such a point is assumed to be something like 0.00005 in., no smaller grooves can be measured. Besides, wear of such fine points has to be taken into account. Mechanically sectioning the surface under test depends upon the method of sectioning, the profile must not be destroyed in the cutting process.

Optical sectioning or "light cut" probably avoids all disadvantages of the other methods and has the further advantage of being equally handy in the workshop as in the laboratory. It has been found that the depth of scratches on the surface can be ascertained down to 0.00005 in. Mr. Way's method is an ingenious development of the Schmaltz method by adding a straightedge shadow and arranging illumination and observation under 60 deg instead of 45 deg. It would be interesting to compare results on a variety of objects. The photographs reproduced with the paper are hardly sufficient to make a fair comparison. Quality of the straightedge, razor blade, may prove an uncertainty in the process as Mr. Way points out.

Both Professor Schmaltz and Mr. Way's methods carry testing of surface finish up to a certain point. Industry, however, insists on measuring means for highly lapped surfaces with a mirror-like finish where the depth of scratches is of the order of a few million parts of an inch. It is to be expected that a micro-interferometer on the Linnik principle will bring the solution. Preliminary experiments in that direction have proved encouraging.

However useful tests on surface finish are to solve engineering problems, their chief aim ought to be and is standardization of surface qualities. Industry needs a definition of the various grades of surface finish from the coarsest machining to the finest lapping. This problem presents certain difficulties. The first serious attempt to solve them may be found in the book by Schmaltz, cited by Mr. Way. Its study can be recommended to everybody interested in this subject.

F. LOEWEN.[9]

[8] "Surface Finish," by Stewart Way, MECHANICAL ENGINEERING, November, 1937, pp. 826-828.

[9] Carl Zeiss, Inc., New York, N. Y.

TO THE EDITOR:

Mr. Way's shadowgraph method of observing and recording surface finish is novel and appears to be both accurate and inexpensive. Relatively low amplification of around 400× would limit investigation of surfaces to such finishes as turning, milling, and regular grinding, where irregularities greater than 0.00003 in. are to be analyzed. In this range of operation, it evidently will fulfill a desirable place in laboratory equipment. The method is also limited to surfaces which will be parallel to a straightedge,

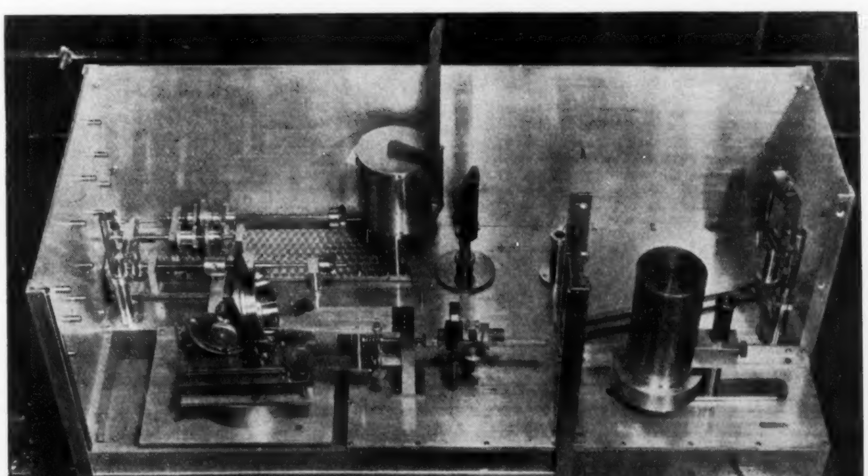


FIG. 2 THE PROFILOGRAPH

(An optical instrument for measuring relative inaccuracies of less than 0.00003 in. and traces of the circumferences of objects by amplifying the movement of a diamond stylus. Results can be recorded on sensitized paper.)

so that curved surfaces could not be inspected. The apparatus has merit in that it gives a true picture of the roughness form of the surface, which is not possible with a stylus recording apparatus.

In the manufacture of fine surfaces, such as ball and roller bearings, gages, piston pins, and the like, irregularities smaller than 0.00003 in. are common. In such articles, we have curved surfaces, where it is important to know how near to true circles these items are manufactured. An interesting piece of equipment, which is shown in Fig. 2, has been developed by the University of Michigan for The Timken Roller Bearing Company. This is an optical instrument that is known as the Profilograph which will measure relative inaccuracies of less than 0.00003 in. and will also allow traces of the circumference of objects to be measured by amplifying the movement of a diamond stylus and records the results on sensitized paper. With this instrument vertical amplifications up to 5000× are possible, which allows variations of 0.000001 in. to be detected. As pointed out by Mr. Way, the graphs obtained are not absolutely true reproductions of actual surface contour but are modified because the radius of the diamond point works on the peaks and valleys instead of an absolute point. This defect, however, can be made extremely small, as noted by the reproduction of a diamond point used on this instrument at 1000 magnification in Fig. 3. The radius at this point is only 0.00005 so that the resulting error is extremely small. Fig. 4 shows four different finishes taken by rectilinear motion at 5000 vertical amplification. From the top downward they are regular grind, mirror, honed, and lapped. The illustration also shows the circumferential trace of a piston pin that had been lapped; the vertical magnification is 3000×. This represents the complete circumference of the piston pin. All views, particularly the circumferential trace, show that the waviness of the surface is obtained, as well as the surface finish.

FIG. 3 DIAMOND POINT USED IN MAKING MEASUREMENTS

(Magnification is approximately 654×.)

Mr. Way's shadowgraph and the instrument just described are both useful in their particular fields. Other instruments meet certain requirements not possessed by either of these methods. It is encouraging to see that at last efforts are being made to provide equipment which will enable us to specify and to measure more accurately the finish required in general engineering practice. Mr. Way should be complimented in advancing the science of surface measurement, hastening the day when some definite standard of surface measurements is accepted.

E. WOOLER.[10]

[10] Chief Engineer, The Timken Roller Bearing Company, Canton, Ohio. Mem. A.S.M.E.

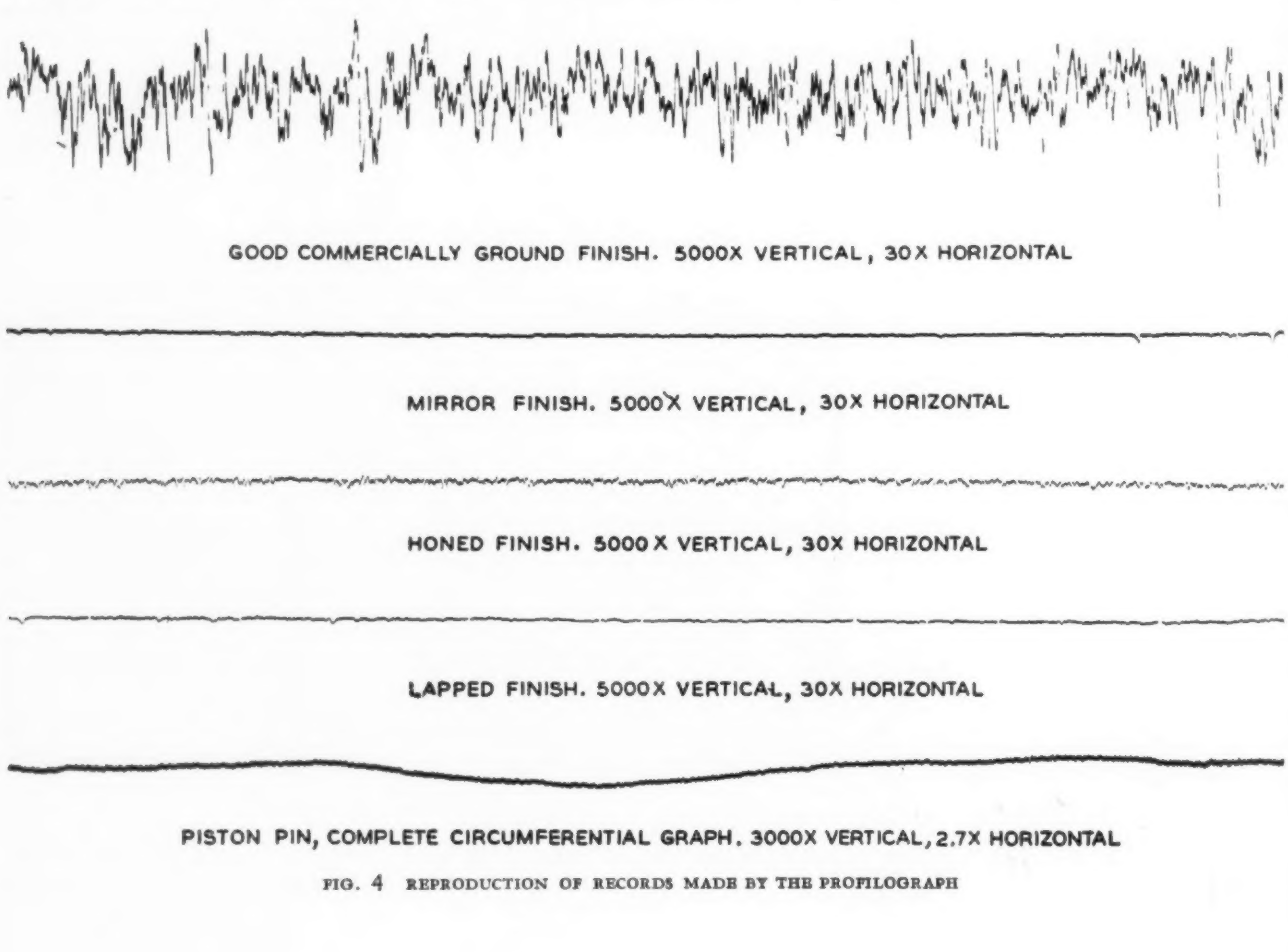


FIG. 4 REPRODUCTION OF RECORDS MADE BY THE PROFILOGRAPH

TO THE EDITOR:

The importance of surface finish in the investigation of bearing performance is rapidly becoming widely recognized. For this reason, any contribution to the science of measuring surface finish or quality is to be welcomed.

The method described by Mr. Way has certain advantages over previously described methods. It is simple and direct. In many cases, it does not involve destruction of the sample and most laboratories have material available for constructing such a device. It does not permit examination of a large portion of the surface at a time, and judging from Fig. 4 of the paper, some difficulty may be experienced in determining the true boundary of the shadow. Part of this may be due to the method of illumination since light is specularly reflected into the microscope and ridges perpendicular to the straightedge will tend to reflect light away from the microscope along their sides, thus causing a dark region on the photograph in which it would be difficult to see the true edge of the shadow. Although Mr. Way has undoubtedly arrived at this method after considerable experimentation, it would be interesting to know why he has not chosen to place the microscope normal to the surface and illuminate at an angle of 45 deg. This also should give a shadow curve proportional to the true profile.

An alternative method suggested itself to the writer. It consists of sealing a stretched filament of wire between two pieces of microscope cover glass by Canada balsam. This could then be placed on the surface being examined and viewed with a higher-power objective than is possible with the device described.

PAUL G. EXLINE.[11]

TO THE EDITOR:

The straightedge-shadow method of rating surface finish is not suitable for work on engine parts and is not able to compete with the stylus-profile method of rating finishes. Its disadvantages are (*a*) insufficient sensitivity, (*b*) limited application, and (*c*) small field of view. As described, the instrument is capable of measuring a minimum of 0.00005 in., while lapped and honed surfaces have average irregularities of from 0.000001 to 0.000003 in. If sensitivity is increased by more optical magnification, difficulties of securing a satisfactory straightedge would be great. The method can be applied only to straight sections and to external surfaces. For instance, it could be used longitudinally on a piston pin but not circumferentially, and it could be used on a cylinder bore only after splitting the block. In common with other optical methods, this instrument gives a field of view of only about $^1/_{16}$ in. and does not permit study of longer irregularities which may be as much as $^3/_8$ in. across.

These disadvantages far outweigh the advantages of the instrument which are (*a*) that it is composed of standard parts and (*b*) that it gives an actual picture of the surface from which complete information can be found. This latter advantage is shared by recording profilographs of the stylus type. The stylus profilograph is free from the disadvantages of insufficient sensitivity and a small field of view and is much better in respect to limitations of application than the shadow instrument.

C. R. LEWIS.[12]
K. K. KARPINSKI.[12]

TO THE EDITOR:

In our work with the S.A.E. extreme-pressure-lubricants testing machine, recently developed for evaluating hypoid-gear lubricants, we have made a few tests in which degree of surface finish was the principal variable. These were film-strength and wear tests of standard Timken test cups and mirror-finished cups with a rubbing ratio of 14.6 to 1. One of the former tests, which was run at 550 rpm with S.A.E. 90 mineral oil, showed a scale load at failure of 100 for the test cup and 220 for the mirror-finished cup. In a 6-hr wear test at 550 rpm and a 50-lb load, the weight loss of the test cup was 1541.2 mg, while that of the mirror-finished cup was only 526.8 mg. These test results are typical of the entire series, and, in each case, use of mirror-finished surfaces resulted in an appreciable gain in performance. Emphasis should be placed on the fact that the regular test cups are by no means rough but are smoothly ground. The mirror cups are of the same type but are buffed to a mirrorlike finish.

The actual mechanism by which these differences are caused is in the speculative stage. Mr. Way describes a type of work that is a step toward the ultimate solution of the problem and will also provide a tool by which production can be controlled and allow the user of bearings and lubricants to obtain the advantages of finer surfaces.

G. L. NEELY.[13]

TO THE EDITOR:

Mr. Wooler remarks that the straightedge-shadow method could not readily be applied when the surface being studied is curved in two directions, since, in that case, the straightedge would contact the surface only at the point of tangency or at the end points in the case of a concave surface. It is found in practice, however, that if the ratio of the length of the straightedge to the radius of curvature in a plane through the edge and normal to the surface is sufficiently small, a satisfactory profile picture can be obtained. If L is the length of the straightedge, r the radius of curvature, and h the difference in elevation of peaks and valleys on the surface, then L/r should be kept less than about $2\sqrt{(h/r)}$ to have a clear profile picture. Thus, if we wish to observe irregularities about 0.0001 in. deep on a surface of 1-in. radius, in a plane passing through the straightedge, a straightedge of 0.02 in. in length should be used. A longer edge could be used if the surface is convex, but a satisfactory profile picture would be obtained only over about the central 0.02 in. of length, which would usually be great enough to contain a fairly large number of irregularities 0.0001 in. in depth. Fig. 4 of the paper shows the profile of a gear tooth, on which the scratches were in the direction of the elements of the cylindrical surface. It was necessary to place the edge perpendicular to the scratches, so that the situation mentioned by Mr. Wooler would arise. Here r was about 1.5 in. and h about 0.001 in., so that a satisfactory picture would be expected over a length of $2 \times \sqrt{(0.001/1.5)}$ or 0.052 in. A profile length of 0.022 in. is shown in Fig. 4.

In reply to Mr. Exline's question relating to the angles of illumination and viewing, the author found it desirable to have the angle of observation equal to the angle of illumination to obtain as much light as possible in the objective of the microscope. Angles of 60 deg are the only ones that fulfill this requirement and, at the same time, give a picture of the profile in its true shape.

The author believes the edge that produces the shadow should be placed as close to the surface as possible to reduce blurring at the edge of the shadow. The closer the straightedge is placed to the illuminated surface, the more sharply defined will be its shadow. Thus, if d is the distance from the edge to the surface and λ is the wave length of light used, the distance from the edge of the geometrical shadow to the point of maximum actual intensity of illumination will be about $\sqrt{(\lambda d/2)}$ so that reducing

[11] Gulf Research & Development Company, Pittsburgh, Pa.

[12] Chrysler Corporation, Detroit, Mich.

[13] Standard Oil Company of California, Richmond, Calif.

d reduces the blurred width. This is the case for collimated light. For noncollimated light, we would have also some blurring in the penumbra region. It is doubtful if a fine wire cemented between two cover-glass disks would give a shadow sufficiently sharp for observation of any but the coarsest of finishes.

The author realizes, with Messrs. Lewis and Karpinski, that the straightedge-shadow method would not be applicable on many engine parts, especially where knowledge of the deviations from the correct shape over lengths of from 0.10 to 0.50 in. is desired.

S. WAY.[14]

"Who's Who in Engineering"

TO THE EDITOR:

A recent paper by President Donald B. Prentice[15] of Rose Polytechnic Institute gives the interesting results of a study of the graduates of 142 engineering schools and colleges in the United States. President Prentice has taken as his criterion of success the publication "Who's Who in Engineering." On this basis the school of engineering of Columbia University stands seventh on the list. Massachusetts Institute of Technology, Cornell University, University of Michigan, University of Illinois, Purdue University, and University of Wisconsin top Columbia in that order in the total number of graduates who have been included.

It is clear, however, that totals alone do not reflect the effectiveness of any educational institution. Dr. Prentice has realized this situation and has secured figures which make it possible to reduce his data to a percentage basis; to tabulate the percentage of the engineering graduates of each institution who are listed in "Who's Who in Engineering." On this basis, the Michigan College of Mining and Technology, with its 1630 graduates and 100 listed, tops the tabulation at 6.13 per cent. Massachusetts Institute of Technology comes next with 5.44 per cent. But, in compiling this latter table, President Prentice has omitted all university engineering schools. "It is not feasible," he says, "to include university engineering schools in this table as graduates in chemistry, physics, or geology are occasionally listed in 'Who's Who in Engineering.'" Presumably, therefore, it is unfair to compare the total graduates of any university listed in this volume with the total of those who have graduated from its engineering school alone.

We note that President Prentice uses the word "occasionally," and we believe that the percentage of nonengineering university graduates who make "Who's Who in Engineering" must be small. Even assuming a 10 per cent increase in the total of living engineering-school alumni to allow for this uncertain number, some interesting results for university engineering-schools would be secured. Columbia, for example, has 6676 men on her engineering-school list. She has granted 5413 engineering degrees but of these 460 were second degrees. Her total of engineering graduates has been thus about 5000. Of this group, about two fifths have passed on during the almost 75 years since the school was founded. Today, therefore, about 3000 living graduates of our engineering school are known and listed in the alumni office. Allowing 10 per cent, as suggested, for nonengineering graduates who would be eligible for inclusion, the Columbia percentage in President Prentice's table would be 292 divided by 3300 or almost to 9 per cent. This is about a 45 per cent greater representation than the highest of those schools listed—than the nonuniversity engineering schools.

This, of course, is pleasing to Columbia. It also suggests that some of the other university engineering schools omitted from this table might show a similar high percentage of notable product. We have long had the feeling that, in these days of broadening engineering interests and outlook, the university engineering school is ideally placed to give the prospective engineer those broader contacts and associations, the more liberal training and viewpoint, which are essential to the modern engineer. The university school, with its departments of science, law, economics, and business, clearly offers educational opportunities that are not normally available in the isolated engineering college. Perhaps the advantages of these opportunities can be shown to be reflected in a higher rating for university engineering schools if data can be secured for the other university schools omitted in President Prentice's tabulation. It certainly is true that Columbia's record is one in which we may justly take pride.

J. K. FINCH.[16]

[14] Research Laboratories, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

[15] "Alumni of the Engineering Colleges," by Donald B. Prentice, MECHANICAL ENGINEERING March, 1938, pp. 241–243.

[16] Renwick Professor of Civil Engineering, Columbia University, New York, N. Y.

A.S.M.E. BOILER CODE

Approval of New Materials Under the A.S.M.E. Boiler Construction Code

PROVISION for the use of new materials in both the A.S.M.E. Power Boiler and Unfired Pressure Vessel Codes requires consideration by the Boiler Code Committee of the materials and their properties to a degree demonstrating the limitations which should be imposed. The following proposed requirements for such information is published below for the guidance of those who wish to obtain authorization to use materials not approved for use in Code vessels:

1 If possible, the material should be identified with an A.S.T.M. specification or tentative specification. If the material varies only slightly from an A.S.T.M. specification by the addition, say, of a small amount of alloying element, it should be stated that the material will comply with some specification except as noted and the exception should be stated not only as to chemical composition, but as to physical properties and test results.

2 If no A.S.T.M. specification can be applied, the following information should be given in the same form as used by the A.S.T.M.:

(*a*) Chemical composition, including for ferrous materials, carbon, manganese, phosphorus, sulphur, and silicon, together with alloying elements, if any.

(*b*) Tensile properties, over the temperature range of contemplated service. Where the vessels are to be stress-relieved or heat-treated, the tensile tests shall be made after the specimens are similarly treated.

In both (*a*) and (*b*) the range rather than an exact determination of the properties should be given within which it is commercially practicable to reproduce the material.

(*c*) Creep strength over temperature range of contemplated service.

(*d*) Corrosion-fatigue tests on high-tensile materials.

3 If any heat-treatment is required to produce the tensile properties, it should be stated.

4 The Brinell or Rockwell hardness should be given unless the information is well known for the material in question. This information

is particularly advantageous if the hardness is higher than for the particular materials specified for boiler pressure parts.

5 If the material is to be used at low temperatures, below 0 F, the impact strength at these low temperatures should be given.

6 It is very important to know whether a new material is subject to critical conditions at temperatures within the range of use or fabrication. By critical conditions is meant a material change in brittleness, hardness, ductility, grain size, etc.

7 It should also be stated if the material is subject to age hardening or critical structural changes by a combination of physical and temperature conditions, such, for example, as the age hardening of certain aluminum alloys after cold working and subsequent heat-treatment. This is particularly important in conditions which might occur during fabrication that result in this critical condition.

8 Unless the material is well known and not unusual in its characteristics, the coefficient of thermal expansion over the range of temperature within which the material will be used should be given, particularly if there is any marked variation from that of ordinary carbon steel.

9 It should be stated whether the material is commercially available and can be purchased within the specified range of chemical and physical qualities. If the material is covered by patents so that it cannot be manufactured by anyone who wishes to use it without securing a license or paying royalties, it should be so stated.

10 If the material is to be welded it should be stated whether any special procedure is required for electric fusion or gas welding and the amount of experience available for determining the weldability. It should be stated whether the material is subject to air hardening during welding. If special procedure must be followed in fusion welding the material, or if the vessel is stress-relieved or heat-treated after welding, the method should be specified, including the proper temperatures.

As a check on weldability, it is recommended that the tests described in Pars. UA-30 to UA-37 be made, unless equivalent information is available.

11 Tests, results of which are submitted to the Boiler Code Committee, should be made upon the thickest plates contemplated, except as otherwise dictated by A.S.T.M. standards.

Revisions and Addenda to Boiler Construction Code

IT IS THE policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from anyone interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

Figs. P-37, L-4, and U-1. Revise captions for these figures to read:

Acceptable Forms of Finished Rivet Heads—For Additional Acceptable Forms See American Standards in Fig. A-13* in the Appendix.

* It is proposed to include in the Appendix with proper reference to the American Standard for Large Rivets (B18.4-1937), dimensions given on pages 11, 12, 13, and 14 of the above standard but deleting all references and data on rivet set impressions.

PAR. P-321. Revise second sentence of third section to read:

When practicable, these connections shall be provided at each right-angle turn with a cross, OR A FITTING WITH A BACK OUTLET TO PERMIT [facilitate] cleaning IN BOTH DIRECTIONS.

PAR. A-20*b*. Add the following sentence:

Fusible plugs which comply with the requirements of the General Rules and Regulations of the Bureau of Marine Inspection and Navigation may have the letters "A.S.M.E." stamped on the casing instead of on the fusible metal.

PAR. L-59. Add the following:

Every superheater which may be shut off from the boiler and permit the superheater to become a fired pressure vessel, shall be equipped with one or more safety valves. No credit shall be taken for the capacity for the additional safety valve.

Manufacturers Data Report Form for Miniature Boilers. Item 4 to read:

Diameter of: Length of:
Shell or Drums.........SHELL [Drums].......
Over all......ft......in......
(Inside of outside course)

PAR. L-61. Replace by the wording of Par. P-272, with the exception that the reference in this paragraph to "Pars. P-281" and "P-273*c*" to be changed to "Pars. L-66" and "L-62*c*," respectively.

PAR. L-62. Replace by the wording of Par. P-273, with the exception that the reference in this paragraph to "Pars. P-272" and "P-281" to be changed to "Pars. L-61" and "L-66," and to Fig. P-44 to be changed to "Fig. L-4$^1/_2$."

PAR. L-63. Replace by the following:

L-63 The safety-valve capacity for each boiler shall be such that the safety valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 5 per cent above the highest pressure at which any valve is set, and in no case more than 5 per cent above the maximum allowable working pressure. The maximum steaming capacity of a boiler shall be determined by the manufacturer and shall be based on the capacity of the fuel-burning equipment, on the air supply, draft, etc. Safety-valve capacity may be checked in the following manner, and if found sufficient additional capacity need not be provided: By making an accumulation test with the fire in good, bright condition and all steam outlets closed; with the fire forced under these conditions the safety valves should relieve the boiler and not allow an excess pressure of more than 5 per cent above working pressure.

PAR. L-64. Replace by the wording of Par. P-276, omitting the last section.

PAR. L-66. Transfer wording of this paragraph as Par. L-17*c*. Insert the wording of Par. P-281 as Par. L-66.

PAR. L-67. Replace by the wording of Par. P-283 and add the following:

Every safety valve used on a superheater discharging superheated steam at a temperature over 450 F, shall have a casing, including the base, body bonnet, and spindle, of steel, steel alloy, or equivalent heat-resisting material. The valve shall have a flanged inlet connection, and shall have the seat and disk of suitable heat erosive and corrosive resisting material, and the spring fully exposed outside of the valve casing so that it shall be protected from contact with the escaping steam.

PAR. L-68. Replace by the wording of Par. P-284.

PAR. L-69. Replace by the wording of Par. P-285, except that in (*b*), the reference to "Par. P-273" to be changed to "Par. L-62."

PAR. L-70. Replace by the wording of Par. P-287, except that the reference to "Par. P-273" should be changed to "Par. L-62."

PAR. L-71. Replace by the wording of Par. P-290, the first sentence only of (*a*) and all of (*b*), adding the wording of present Par. L-66 as (*c*).

PAR. U-61. Add the following as (*c*):

c When plates under $^1/_4$ in. are formed into heads of small diameter, the marking requirements of plate specifications may be stenciled in one place with the manufacturer's name and test identification number. The mill certification of the physical and chemical requirements of this material, in conjunction with the above modified marking requirements, shall be considered sufficient to properly identify these heads.

PAR. U-72*a*. Revise last sentence to read:

In all cases the forming, IF DONE COLD, shall be [done] by pressure and not by blows, including the edges of the plates forming longitudinal joints of cylindrical vessels. CARBON STEEL PLATES, CONFORMING TO THE SPECIFICATIONS IN THE CODE, WHICH ARE TO BE SUBSEQUENTLY STRESS-RELIEVED, MAY BE FORMED BY BLOWS PROVIDING THIS IS DONE WHILE THAT PORTION OF THE PLATE IS AT A FORGING TEMPERATURE AND THAT SUCH FORMING DOES NOT OBJECTIONABLY DEFACE THE PLATE.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Metal Airplane Structures

Metal Airplane Structures. By Flavius E. Loudy. Norman W. Henley Publishing Co., New York, N. Y. Cloth, 6 × 9 in., 455 pp., 293 figs., $5.

Reviewed by Alexander Klemin[1]

IF THE HISTORY of the last ten years on airplane construction is briefly reviewed, the following events stand out clearly. First of all, wood, wire, and fabric construction was displaced in favor of tubular steel fuselages and wing spars of steel or aluminum alloy, still with fabric covering. Then, the metal structure with fabric covering yielded rapidly to a metal truss with metal covering, the metal covering acting only partially as a reinforcing agent. Finally, the stressed-skin construction has come with the thin skin taking perhaps the major part of the load. In airplane construction, therefore, as perhaps in no other branch of engineering, designers have made use of a thin metal skin to take up a variety of stresses. At the same time, airplane construction has led almost inevitably to the utilization of thin profiles or sections, channels, tubes, shells, or cylinders. In fact, the distinctive mark of modern airplane construction is the emphasis on thin elements and its greatest difficulty lies in the buckling, crinkling, or other "stability" failures of these thin elements. Again, in the days of the old "stick and wire" airplane, spars, ribs, and fuselage members attained a high degree of standardization. This was unavoidable because so little could be done apparently with wood shapes. With metal construction, a fantastic variety of sections is always employed. Sheet metal has been used in every possible manner. Spars may be built up in the form of a Pratt truss, or may be box beams, or built-up girders, or girders of the tension field variety with thin webs. With this immense variety of forms and with the special difficulties of thin sections to be considered, reliance on calculations of main-member stresses has had to yield to the most refined analysis of secondary stresses and local strength. Today, it may be said that the structural analysis of aircraft, owing to its complexity, is still in an uncertain condition and designers still rely on tests to destruction and past experience for determination of structural strength, in addition to the most careful calculations.

[1] Professor of Aeronautical Engineering, Daniel Guggenheim School of Aeronautics, New York Univ., New York. Mem. A.S.M.E.

In view of this general situation, it will be readily admitted that Mr. Loudy's book on Metal Airplane Structures is timely. It does not offer a true systematic presentation of methods of analysis, but it will be of real value to both designers and constructors. In the first place, the author has collected within the covers of one book the properties of a wide variety of the structural elements employed—columns, tubes, angles, extruded shafts, and the like. He has given a chapter on the strength and design of welded and riveted joints which naturally are of great importance in aircraft construction, with results of basic tests as supporting material and illustrations from current practice. Allowable stresses for combined bending and compression stresses and strength curves for tubing and channels are assembled into a useful reference section with the formulas clearly presented. Riveted products and illustrations from actual airplanes are freely given. In the chapter on stressed-skin design, the author has again pursued the plan of collecting a variety of tests and has indicated clearly how these results may be considered from a theoretical standpoint. Useful general conclusions are also drawn from these tests, and careful discussion is given on such points as the distribution of load between sheet and stiffeners in compression elements. This is one of the typical difficulties that our aircraft analysts are faced with and it is highly interesting to see these facts brought out in relation to the test data.

The author presents the same sort of analysis for thin web, sometimes known as Wagner beams, a special type of girder in which the shear force is small compared with the depth, so that the required web thickness is small. Such a thin web would naturally buckle before it reached its ultimate shear stresses. To develop the shear stresses in a thin web, an intolerable number of stiffeners would be required. In the Wagner beam, a different solution of the problem has been developed. The flanges of the beam are connected by a number of struts which act not as a web structure but merely as flange spacers. The web left free to buckle, cannot carry the shear in the beam but does carry shear by the development of tensile stress; hence, the name tension-field beams.

In metal wings and metal-wing beams, an interesting collection of practice, both in the United States and abroad, is presented. It is interesting to see how practice in various countries has developed on somewhat different lines. In fuselage construction, the same typical review and discussion of tests is followed. A bibliography summarizes the most important papers in this field. While this book may not completely satisfy the advanced technician because the methods of analysis are not fully developed, it should be of great value to aeronautical students at universities and to younger engineers in practice who should receive from their instructors a more classical presentation of the subject. University teachers will inevitably turn to the book as a real help in either stress-analysis or design classes.

Books Received in Library

Air Conditioning Furnaces and Unit Heaters. By J. R. Dalzell. American Technical Society, Chicago, 1938. Cloth, 6 × 9 in., 430 pp., illus., diagrams, charts, tables, $3. A practical treatise on air conditioning as connected with heating systems. The general principles of ventilation and air conditioning are given, together with information on heat transmission, heating and cooling loads, humidification and insulation. Equipment described includes gravity and mechanical furnaces, registers and grilles, unit heaters, electric heating, and automatic controls. Technical-code applications and a psychrometric chart are included.

Corso di Resistenza delle Artiglierie. By G. Isidori. Casa Editrice Raffaello Giusti, Livorno, Italy, 1937. Cloth, 6 × 9 in., 383 pp., diagrams, charts, tables, 75 lire plus 7.25 lire postage. Recent developments in the theory of elastic resistance are described, mainly concerned with the causes and effects of particular strains and stresses as set up in hollow cylinders. The practical application of these theories is considered with respect to internal pressures in guns.

ENGINEERING METALLURGY. By B. Stoughton and A. Butts. Third edition. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 525 pp., illus., diagrams, charts, tables, $4. A new edition of a standard textbook on metallurgy for the engineer. The most important addition is a chapter on the applications of metals and alloys in engineering design. Other topics covered include metals and other construction materials, ores and ore treatment, chemical and mechanical metallurgy, properties, uses and heat-treatment of ferrous and nonferrous metals and alloys, corrosion, fuels and pyrometry.

HOW TO FILE BUSINESS PAPERS AND RECORDS, By A. Chaffee. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 8 in., 186 pp., illus., diagrams, charts, tables, $2. Filing systems and their operation, filing routines, and filing equipment are discussed in detail, showing the advantages inherent in certain types which make them particularly valuable in various specific cases. Useful both for the office manager who wants the system best suited to his purposes, and for the clerk who wishes to become proficient in filing.

HOW TO KEEP ACCOUNTS AND PREPARE STATEMENTS. By E. A. Saliers. Ronald Press Co., New York, 1938. Cloth, 5 × 8 in., 481 pp., charts, tables, $3. This text is intended for those who wish a practical understanding of accounting, but lack time or opportunity for a formal course of instruction. It presents a course in principles, with full explanations, which will give a working familiarity with methods and equip the reader to prepare the statements usually required in business.

INDEX TO A.S.T.M. STANDARDS AND TENTATIVE STANDARDS as of January 1, 1938. American Society for Testing Materials, Philadelphia, Pa., 1938. Paper, 6 × 9 in., 119 pp., 6 × 9 in., gratis. Contains both a classified index and a numerical list of all standards as of January 1, 1938; these standards cover specifications, test methods, and definitions as adopted by the Society.

KINETIC THEORY OF GASES. By E. H. Kennard. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 483 pp., diagrams, charts, tables, $5. The main portion of the book constitutes a treatise on the traditional kinetic theory of gases, although from a strictly modern viewpoint, which is suitable for use as a textbook for upper-class students. In addition there are two chapters of graduate grade on wave mechanics and general statistical mechanics. The electrical and magnetic properties of gases are treated only briefly, being too wide in scope for complete coverage here.

KRAFTFAHRTECHNISCHE FORSCHUNGSARBEITEN, No. 10. Edited by V.D.I. V.D.I. Verlag, Berlin, 1937. Paper, 8 × 12 in., 26 pp., illus., diagrams, charts, tables, 3.50 rm. A collection of three papers on automotive research: a discussion of automobile brake testing; an analysis of the action of four-wheel brakes; and a brief consideration of the kinematics and the balancing of masses in four-cylinder U-engines.

MAGNESITE AS A REFRACTORY. By A. W. Comber. J. B. Lippincott Co., Philadelphia and New York, 1938. Cloth, 5 × 8 in., 114 pp., illus., diagrams, charts, tables, $2. This volume, the first to deal specifically with its subject, brings together the various considerations which should control the preparation of the material and its industrial employment. In a brief, yet practical way, it discusses the properties of magnesite, its occurrences, its preparation as a refractory, and its use in steelmaking and other industries.

MAGNETISM. (Physics in Industry.) Institute of Physics, London, 1938. Cloth, 6 × 10 in., 102 pp., illus., diagrams, charts, tables, 4s 6d and 4d postage. This volume contains six lectures by physicists and engineers, which were delivered in 1937 before the Manchester and District branch of the Institute of Physics. The talks were designed to survey our present knowledge of the magnetic properties of materials. The topics discussed were: Magnetism and the electron theory of metals; electrical sheet steel; the influence of the properties of available magnetic materials on engineering design; magnetization curves of ferromagnetics; permanent magnets, and X-ray studies on permanent magnets of iron, nickel, and aluminium.

MANUFACTURE OF PULP AND PAPER, Vol. 4. Edited by Joint Textbook Committee of the Paper Industry of the United States and Canada. Third edition. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., paged in sections, illus., diagrams, charts, tables, $6.50. This book presents a thoroughly revised edition of the fourth volume of a practical text upon pulp and paper manufacture which is sponsored by the paper industry of the United States and Canada. This volume is devoted to paper manufacture, and discusses the pulping of rags, processing waste papers, the beating, loading, sizing, and coloring of paper stocks, and mill equipment. The book is intended for class use and home study.

MODERN RUBBER CHEMISTRY. By H. Barron. Chemical Publishing Co., New York, 1938. Cloth, 6 × 9 in., 341 pp., illus., diagrams, charts, tables, $7.50. This treatise on the scientific principles of rubber manufacture has a relatively wide coverage. Intermixed with chapters on the theory and principles of rubber structure in its various stages appears material on manufacturing processes and machinery, vulcanization, accelerators, aging methods, reclaimed and synthetic rubber, and rubber analysis.

NATIONAL FIRE CODES FOR FLAMMABLE LIQUIDS AND GASES, compiled by R. S. Moulton. National Fire Protection Association, Boston, Mass., 1938. Paper, 6 × 9 in., 360 pp., diagrams, tables, $1.50. A compilation of the 36 standards and regulations that deal with the various phases of the hazards of flammable liquids and gases. The codes cover methods and equipment for handling, transporting, storing, and using such materials as will provide reasonable fire safety.

DIE PUMPEN. By H. Matthiessen and E. Fuchslocher. Fourth edition. Julius Springer, Berlin, 1938. Paper, 6 × 9 in., 118 pp., illus., diagrams, charts, tables, 3.90 rm. The two major sections of this book are devoted to the efficiency, types, calculations, and structural design and details of piston pumps and rotary pumps. There are also brief chapters discussing compressed-air and steam pumps, the hydraulic ram and injectors.

SCIENCE OF PETROLEUM, 4 vols. Edited by A. E. Dunstan, A. W. Nash, B. T. Brooks, and Sir H. Tizard. Oxford University Press, London, New York, and Toronto, 1938. Cloth, 8 × 11 in., 3192 pp., illus., diagrams, charts, tables, maps, $85. This monumental work is intended as an encyclopedia of the petroleum industry, in which may be found a balanced, comprehensive, critical discussion of every aspect of the prospecting, production, refining, and transport of mineral oil and gas. Over three hundred specialists have contributed to it. The first volume is devoted to the origin and production of crude petroleum, Volumes 2 and 3 discuss the physical and chemical properties of petroleum. Volume 4 treats of the utilization of mineral oils and their derivatives, of detonation and combustion, and of bituminous materials and their products. The work is illustrated by maps, charts, and photographs; bibliographies are appended to the sections, and name and subject indexes are provided. The treatise should be most valuable to all workers in this field.

VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA. D. Van Nostrand Co., New York, 1938. Leather, 8 × 11 in., 1233 pp., illus., diagrams, charts, tables, $10. This encyclopedia aims to provide a reference book covering the basic sciences of physics, chemistry, mineralogy, geology, botany, astronomy, and mathematics; and the applied sciences of engineering, medicine, navigation, and aeronautics. Over ten thousand terms of interest are included, with definitions and fundamental information. The articles are clear and concise, illustrations are used freely, and the information appears to be accurate and up to date. The arrangement is alphabetical, with numerous cross-references. The work can be recommended as filling a decided want.

WAGE INCENTIVE METHODS. By C. W. Lytle. Ronald Press Co., New York, 1938. Cloth, 6 × 9 in., 468 pp., diagrams, charts, tables, $6. The aim of this book is to assist the selection of the best wage plan for any business, by providing means for comparison of possible methods. It presents all the basic incentive plans in use, with their variations and modifications. Twenty-five plans are described and analyzed in detail and their strong and weak points presented impartially. This edition has been revised and enlarged, and a new chapter on recent developments has been added.

WERKSTOFF MAGNESIUM. V.D.I. Verlag, Berlin, 1938. Paper, 6 × 8 in., 149 pp., illus., diagrams, charts, tables, 7.50 rm. This work contains the addresses given at two meetings of German engineering societies which were devoted to consideration of magnesium as an engineering material. The physical and chemical properties of the metal, the fields of possible application, methods of casting and shaping, corrosion, and surface protection are described. There are also papers on the uses of magnesium alloys in the automobile and electrical industries.

WOOD PRESERVATION. By G. M. Hunt and G. A. Garratt. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 457 pp., illus., diagrams, charts, tables, $5. The aim of the authors has been to summarize the essential facts on wood preservation and provide a clear presentation of its fundamental principles. The various agencies of wood deterioration, wood preservatives and preserving processes and equipment, and the properties of treated wood are all discussed fully.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

St. Louis Doing Itself Proud for A.S.M.E. Semi-Annual Meeting, June 20–24, 1938

THE INDUSTRIES of St. Louis are opening their doors to The American Society of Mechanical Engineers during the Semi-Annual Meeting, June 20 to 24, 1938. The St. Louis Section of the Society has departed from the usual plan for inspection trips, and although there will be regularly scheduled trips on Wednesday and Thursday afternoons, June 22 and 23, the local committee has arranged its plans so that those members not able to go on the trips as planned at the scheduled time, may still be able to visit plants in St. Louis.

We're Off

Trips have already been arranged definitely at Anheuser-Busch, Broderick and Bascom Rope Co., Busch-Sulzer Diesel Engine Works, Cahokia Power Plant of the Union Electric Company, Fisher Body Plant, Granite City Steel Company, the new City Water Works Plant at Howard's Bend, the Midwest Piping and Supply Co., the Laclede Gas Light Co., and the Laclede-Christy Clay Products Co. Arrangements are now under way for trips to Owens-Illinois Glass Co., Pevely Dairy, St. Louis Car Co., and Western Cartridge Co.

An attempt has been made to choose plants in which there is some special attraction. To mention only a few, there are the five new boiler units and two new generating sets at the Cahokia plant; the new continuous-strip mill at Granite City Steel; unusual pipe-bending equipment at Midwest Piping; the latest in water-filtration equipment at Howard's Bend; new installations of bottling equipment and power-plant equipment at the world's largest brewery and one of Fisher Body's finest assembly plants. Members will be able to choose their trips and time of going when they register and the St. Louis Section will take care of the rest.

A trip is also planned to Washington University for those who wish to see the campus and engineering buildings. The University has to its credit a distinguished group of graduates who have taken high rank in professional and executive positions including the presidencies of The American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Chemical Engineers, American Institute of Mining and Metallurgical Engineers, and numerous other organizations of local and national importance.

Courtesy St. Louis Convention Bureau

THE HISTORIC "OLD CATHEDRAL" IN DOWNTOWN ST. LOUIS

(Favors were conferred on this old cathedral granted to no other church in the world except the basilicas in Rome. Because of its historic significance, no sight-seeing tour of the city is complete without a visit to it.)

THE CITY HALL, ST. LOUIS

(Houses executive offices of the City's officials.)

Under its charter the University conducts thirteen schools, covering liberal arts, engineering architecture, business administration, law, dentistry, fine arts, medicine, botany, and so on.

Entertainment

The Entertainment Committee has not been idle in its work of providing entertainment for the Semi-Annual Meeting. A smoker has been arranged for Tuesday evening, June 21, for which the program is being arranged with unusual care. After the banquet program is completed on Wednesday night, one of the leading St. Louis orchestras will provide music for dancing.

Nor has entertainment for the women at the

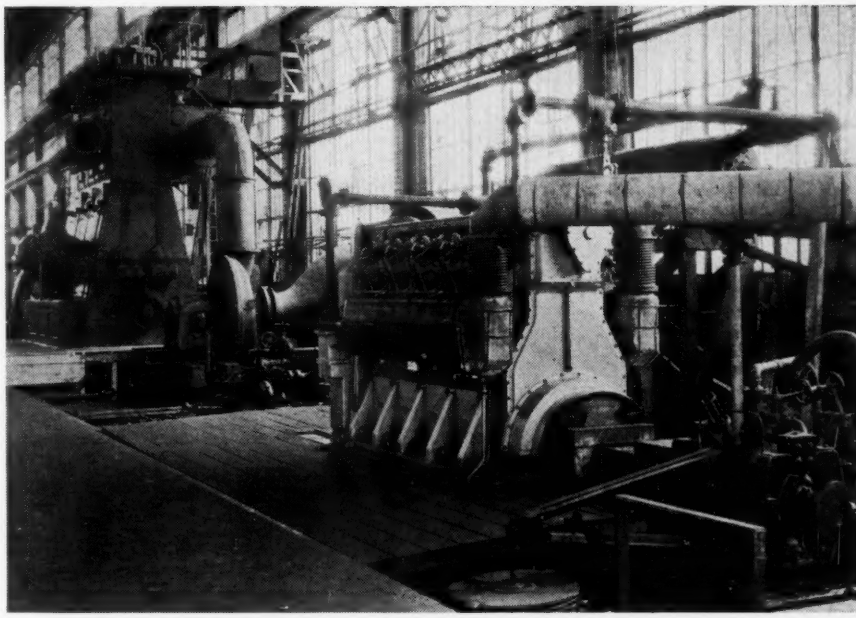
Meeting been neglected. A sight-seeing trip has been scheduled for Monday afternoon, and other trips, to the Missouri Botanical Garden, the Municipal opera, the Art Museum, and to the Lindbergh Trophies will complete the program for the week.

Technical Asides

After all, there will be technical sessions although this is not the time to tell you about them. A complete program will come along next month with the papers and authors all listed in their impressiveness.

However sessions are being sponsored by the Railroad, Process Industries, Fuels, Management, Machine-Shop Practice, Hydraulic, and Iron and Steel Divisions, as well as by the Boiler-Feedwater, and Education and Training for the Industries Committees.

The Calvin Rice Memorial Lecture will be delivered by William Eobb Barclay, O.B.E., well-known English metallurgist, who tells us his subject will be along the lines of contributions of metallurgy to engineering progress—he adds "possibly your members may be interested in the point of view of an industrial metallurgist who has lived through a particularly active generation."



AT THE BUSCH-SULZER BROS. DIESEL ENGINE CO. PLANT—A TEST BED WITH LARGE THREE-CYLINDER 30 × 52 ENGINE ON TEST ALONG WITH SOME SMALLER UNITS

(An inspection trip is planned to this plant during the Semi-Annual Meeting of the A.S.M.E. in June. The plant is devoted primarily to the production of medium and large-size heavy-duty engines. The company completed at St. Louis in 1898 the first American Diesel which was also the first one in the world to be placed in commercial service.)

And we think the words "particularly active" an understatement, for we read that Mr. Barclay, sometimes lecturer in electrometallurgy, University of Sheffield, is consulting metallurgist with Mond Nickel Co., Ltd., a past-president of the Institute of Metals, and the Birmingham Metallurgical Society, and vice-chairman of the British Non-Ferrous Metals Research Association; that he is author of many technical papers in the metallurgical field; that he has been awarded the Thomas Turner Gold Medal by the University of Birmingham for distinguished services to industrial metallurgy, and that during the World War he served as chief metallurgist to the Non-Ferrous Rolled Metal Section of the Ministry of Munitions.

THE A.S.M.E. 1938 SEMI-ANNUAL MEETING IN ST. LOUIS

Week of June 20, 1938

CHAIRMEN OF COMMITTEES ON ARRANGEMENTS

General Arrangements Committee

C. J. Colley, Chairman
W. E. Bryan, Vice-Chairman
E. H. Sager, Secretary
R. M. Boyles, Treasurer
C. B. Briscoe, Assistant Secretary
Charles Hatfield, Advisory Member[1]

Finance
D. Larkin, Chairman
A. Vigne, Vice-Chairman

Technical Sessions
E. H. Tenney, Chairman
G. V. Williamson, Secy.

Trips, Transporation
A. K. Howell, Chairman

Hotel
G. L. Shanks, Chairman

Entertainment
A. J. Leussler, Chairman

Information, Registration
R. C. Thumser, Chairman

Banquet
R. W. Merkle, Chairman

Publications, Printing
A. L. Heintze, Chairman

Reception
L. C. Farquhar, Chairman

Ladies
Mrs. E. H. Sager, Chairman

Publicity
D. E. Dickey, Chairman

[1] Representing the St. Louis Convention Publicity and Tourist Bureau.

Last Call for Machine-Shop Meeting in Rochester, N. Y., May 10–12, 1938

THIS IS the final notice—that the A.S.M.E. Machine Shop Practice Division is to hold its meeting in Rochester, N. Y., May 10–12, with headquarters at the Hotel Sagamore. Members of the Society with machine-shop interests are urged to attend or to send a representative from their organizations.

As the program, published in the April issue, p. 349, indicated, there is a particularly well-balanced schedule of papers and shop trips planned for the three days.

On Tuesday, Wednesday, and Thursday mornings technical sessions will hold sway, the afternoons being left free for inspection trips, outdoor sports, or for drives about Rochester, one of the loveliest of cities.

On Tuesday evening Carl L. Bausch of the Bausch & Lomb Optical Company will discuss inspection procedure while George B. Heddendorf will be the speaker at the dinner on Wednesday evening. Mr. Heddendorf, who is connected with the education department of the International Business Machines Corporation, will talk on apprentice training. Kenneth H. Condit, editor of *American Machinist*, will be the toastmaster at the dinner.

All the sessions and the dinner will be held at the Hotel Sagamore. There will be no registration fee. Pass the word along to your machine-shop friends. They will be glad you let them know.

Over 500 Attend A.S.M.E Spring Meeting at Los Angeles

Fine Sessions at Pacific Coast Meeting Provoke Lively Discussion; President Davis Speaker at Banquet; Excursion Schedule Praised

THE FIRST Spring Meeting in the new annual four-national-meeting schedule of the A.S.M.E., held at Los Angeles, Calif., March 23–25, 1938, proved highly successful in spite of flood conditions. Over five hundred were in attendance at the twelve sessions.

A program of 31 papers provided opportunity for technical discussions on hydraulics, petroleum, process industries, management, fuels, aeronautics, and applied mechanics at sessions which were uniformly well-attended, with several overflow audiences.

To the Local Committee goes the credit and appreciation for the complete arrangements which were carried out smoothly even when flood conditions caused last-minute changes in plans.

Registration headquarters at the Hotel Biltmore were opened at 1 p.m. on Tuesday, the day before the meeting started, to accommodate members who were arriving from out of town, and registration became an all-day affair from eight in the morning to nine in the evening. The customary "authors' meals" were served before each session with practically a hundred per cent attendance, on the well-founded theory that engineers do a better job of presenting papers after they have been well fed and put in a proper frame of mind by meeting and talking with the presiding officers of the day's sessions. George M. Eaton, who became perfected in the technique of handling such gatherings as a member of the A.S.M.E. Standing Committee on Meetings and Program, was in attendance.

Hydraulics the Keynote

A session on hydraulics started the meeting off—and most appropriately—for while important in itself, under the rather unusual weather conditions prevailing, "hydraulics" was indeed the keynote of the meeting.

And from a successful start the sessions went right along in accordance with the program, there being but one major change. The petroleum and process sessions scheduled for Wednesday morning were combined, because of the difficulty some of the authors experienced in getting to Los Angeles.

Particularly pleasing features of the meeting were the uniformly active discussion at the sessions and the fine attendance at the evening presentation of technical programs.

Excursions

Perhaps the most interesting part of the program to everyone, was the excellent schedule of excursions.

Plant visits, of course, were of major interest. The Vernon Diesel plant, which was formerly a municipal plant and is one of the largest of its kind in the United States, having a capacity of 25,000 kw, drew a large crowd, as did Kobe, Inc., plant, manufacturer of flame-cut oil-well strainers and a novel type of deep-well oil pump.

The trip to the Lockheed plant was the only aircraft excursion included and the attendance was particularly good.

The California Institute of Technology visit attracted many for the grinding of the mirror for the 200-in. telescope for the Mt. Palomar observatory was in progress there and visitors were able to see the complete pump-testing laboratory where much development work was done on the large pumps for the Metropolitan Water District. Work for the Grand Coulee project was in progress in the laboratories.

R. L. DAUGHERTY
Chairman, Technical Events

H. L. DOOLITTLE
General Chairman for Meeting

H. L. EGGLESTON
Secretary, General Committee

The Long Beach Steam plant of the Southern California Edison Company with its modern methods of burning natural gas and oil was another of the especially worth-while trips.

The Universal Studios

However, the Thursday evening visit to the Universal Studios probably excited the most interest.

Because of the crowded conditions on the sound stages it was necessary *strictly* to limit attendance to 300. This was the first time since sound pictures were developed that the studios had been opened to anyone not closely identified either with the industry or with that particular studio.

It was stated that the actual cost of the trip to the studio was between $2500 and $3000. All the promises made in the program were kept and abundantly so. Even the Los Angeles people were enthused over the party, for practically none of them had ever seen anything of the kind. After the cameramen had made several shots for a picture in production, they "took" President Harvey Davis with Mr. Trasker who was in charge of the sound department. The show lasted almost four hours and covered a complete insight into the intricacies of making sound pictures and its many difficult engineering features. All of the heads of departments of Universal but one appeared, and were most thoughtful in their kind attentiveness.

The Banquet

The banquet was held on Friday evening in the ballroom of the Biltmore Hotel with 225 present. Professor William Howard Clapp, of the University of California, did a finished job as toastmaster, introducing the speakers, Dr. Harvey N. Davis, president of the A.S.M.E., and President of Stevens Institute of Technology, and Dr. Earl R. Hedrick, member, A.S.M.E., provost of the University of California. Dr. Davis' talk was on "The Engineer of the Future" while Dr. Hedrick's subject was "The Engineer in Public Life." Able speakers both, they had an enthusiastic and attentive audience.

A "fifty-year" badge was presented to Spencer Miller, who became a member of the Society in 1888 and served as one of its managers from 1914 to 1917, and as vice-president from 1917 to 1919.

The reception and dance which followed brought the meeting to an official as well as enjoyable close.

Women's Program

The program for the women—and there were about a hundred present—was most efficiently handled with Mrs. J. G. Rollow as chairman, who had as members of her committee Mrs. W. H. Clapp, Mrs. H. L. Doolittle, Mrs. S. F. Duncan, Mrs. T. T. Eyre, Miss K. H. Ackstaff, Mrs. H. M. Perry, Mrs. R. R. Robertson, and Mrs. C. C. Thomas.

The trip to the famous Huntington Library with its world-known Art Gallery proved of special drawing power, while drives through the country were arranged and carried out despite untoward conditions. The excursion

AT THE BANQUET AT THE HOTEL BILTMORE, LOS ANGELES SPRING MEETING

[It's pretty hard to show this picture to your family and say "I was there," so while it is impossible to list all of the guests, we are telling you definitely who is at the speakers' table. Reading from right to left (and we mean that), are: Frank H. Prouty, Manager A.S.M.E., Prof. R. L. Daugherty, past Vice-President, E. W. Burbank, Manager, Mrs. Clarke Freeman, W. Lyle Dudley, Manager, Mrs. H. L. Doolittle, Dr. Earl Hedrick, Speaker, Mrs. H. N. Davis, Prof. W. H. Clapp, toastmaster (Chairman Los Angeles Section), Dr. H. N. Davis, President A.S.M.E., Mrs. Earl Hedrick, Warren McBryde, Vice-President, Mrs. W. H. Clapp, Spencer Miller (awarded 50-year badge), Mrs. W. Lyle Dudley, H. L. Doolittle, past Vice-President A.S.M.E. (Chairman Los Angeles Meeting Committee), Mrs. R. L. Daugherty, and Clarke Freeman, Chairman, A.S.M.E. Standing Committee on Meetings and Program.]

to Mt. Wilson observatory had to be canceled because of washed-out roads.

The luncheon on Friday at the Assistance League in Hollywood was another popular event with the women. The many movie stars present and the spring fashion show added to the general attractiveness of the occasion.

However, with so much of interest in and about Los Angeles no one was found who was not thoroughly enjoying herself.

The Applause

When it comes to giving credit for the arrangements of a meeting of this kind, there is great difficulty, for everyone did his best to make it successful.

However, to H. L. Eggleston a particular vote of thanks was given at the banquet. Special tribute should be paid also to H. L. Doolittle, W. H. Clapp, and R. L. Daugherty. And unanimous huzzahs to J. Calvin Brown who was entirely responsible for arranging the motion-picture studio trip and to James T. Holmes, Earl Mendenhall, J. R. Hoffman, R. M. Beanfield, R. R. Robertson, F. M. Beeson, Mr. and Mrs. H. M. Perry, and Mrs. J. G. Rollow for particular helpfulness.

The personnel of the committees as it appeared on the program follows:

General Committee

H. L. DOOLITTLE, *Chairman*

H. L. EGGLESTON, HARRY S. HOUGHTON — *Secretaries*

E. C. BARKSTROM	A. M. GILMORE
R. McC. BEANFIELD	J. R. HOFFMAN
F. M. BEESON	J. T. HOLMES
J. CALVIN BROWN	EARL MENDENHALL
W. H. CLAPP	R. R. ROBERTSON
R. L. DAUGHERTY	W. B. ROSS

E. KENT SPRINGER

Finance Committee

E. C. BARKSTROM, *Chairman*	R. V. LABARRE
S. M. DUNN	EARL MENDENHALL

Technical Events Committee

R. L. DAUGHERTY, *Chairman*

R. McC. BEANFIELD	H. L. DOOLITTLE
W. H. CLAPP	S. F. DUNCAN
C. K. COBERLY	H. L. EGGLESTON

Hotel Committee

F. M. BEESON, *Chairman*	J. T. HOLMES
WILHELM BOTTICHER	B. N. PALM
J. ROY HOFFMAN	E. KENT SPRINGER

Entertainment Committee

J. CALVIN BROWN, *Chairman*

F. M. BEESON, J. ROY HOFFMAN, A. M. GILMORE

Trips and Transportation

J. ROY HOFFMAN, *Chairman*

PAUL F. ARNERICH	JOHN M. HANNA
LOUIS W. BALLARD	J. H. LEEDS
ORRIN R. BROBERG	FRED C. LONG
WM. A. BURKE, JR.	J. A. MILLINGER
C. J. COBERLY	HARLAN MURRAY
HAL FOSTER	CHESTER PIERCE
JOHN P. FOSTER	ANDREW H. ROSE
EDWIN M. GETZMAN	E. KENT SPRINGER

Registration Committee

J. T. HOLMES, *Chairman*	J. GRADY ROLLOW
CAL AUSTIN	JEROME SIMPSON
J. A. GARRETT	T. W. SELSER
SCOTT JENSEN	E. KENT SPRINGER
ROBT. C. KUPFER	CHAS. W. WALKER
F. H. NOLTIMIER	HAROLD R. SWANTON
F. H. PODMORE	D. P. VAIL
JUSTIN RADAK	GUY L. WARDEN
D. K. ROLLOW	FRANK WHITE

Publicity Committee

R. McC. BEANFIELD, *Chairman*

W. B. ROSS, *Cochairman*

Reception Committee

R. R. ROBERTSON, *Chairman*	H. M. PERRY
J. D. HACKSTAFF	A. A. SCHMIDT
SMITH LEE	CARL C. THOMAS

Women's Committee

MRS. J. G. ROLLOW, *Chairman*

MRS. W. H. CLAPP	MISS K. HACKSTAFF
MRS. H. L. DOOLITTLE	MRS. H. M. PERRY
MRS. S. F. DUNCAN	MRS. R. R. ROBERTSON
MRS. T. T. EYRE	MRS. C. C. THOMAS

Engineers' Luncheon

One event not scheduled on the final program was the "Engineers' Luncheon" for which last-minute arrangements proved particularly happy as Dean Robert L. Sackett was prevailed upon to make the trip from Tucson to speak. His talk, "The Engineer in Public Service," was a high spot of the Meeting.

The Western Metal Congress

Running simultaneously with the A.S.M.E. Spring Meeting was the Western Metal Exposition, the technical sessions of the Western Metal Congress and the American Welding Society.

Keen interest was shown in new developments as was indicated by the large attendance, mainly drawn from the eleven western states, although approximately 500 visitors from the East were present.

New Procedure for Planning National Meetings Approved by Council

Professional Divisions Responsible for Content and Conduct of Technical Sessions

TO INSURE better coordination in the preparation of programs for the National Meetings of the Society, the Committee on Meetings and Program, with the approval of the Committee on Professional Divisions, recommended to Council the adoption of a procedure which would enable the delegation of responsibility for the technical sessions to the latter committee. At its March 14 meeting, the Executive Committee of Council considered the recommendation and approved the following procedure:

Responsibility for the preparation and conduct of National Meetings of the Society rests with the Committee on Meetings and Program by Art. B9, Par. 6 of the By-Laws.

All meetings of the Society, except business meetings, shall be in charge of the Committee on Meetings and Program, under the direction of the Council (also covered in Art. B6A. Par. 13).

In accordance with this By-Law, the Committee on Meetings and Program has the responsibility for the content, arrangements, and conduct of meetings.

Preparation of Technical Programs

In order to improve coordination of program requirements and preparation of technical papers, responsibility for content and conduct of technical sessions is delegated to the Professional Divisions as outlined:

1 Upon approval by the Council of the place and date of a Society Meeting, the Committee on Meetings and Program shall inform the Committee on Professional Divisions as to the number of technical sessions available, and the schedule for such sessions.

2 Upon the nomination of the Executive Committee of the Local Section at the place where the meeting is to be held, the Committee on Meetings and Program shall appoint a local committee for the meeting and advise the Committee on Professional Divisions as to the personnel of the local committee.

Assistance of Local Committees

3 Prior to formulating the program for any meeting except the Annual Meeting, the Committee on Professional Divisions shall invite the Local Committee where the meeting is to be held to express opinion in regard to topics which should be included, names of authors, and matters of general interest which should be served by the meeting. This action shall be taken at least ten months prior to the meeting date and the results shall be transmitted directly to the Divisions concerned, to the Local Committee and to the Committee on Meetings and Program.

4 The Committee on Professional Divisions shall formulate the technical-session program for all meetings at least six months prior to the scheduled date of the meeting and shall report such action to the Committee on Meetings and Program by that time. Upon approval, the technical-session program shall be transmitted to the Local Committee concerned.

5 The Committee on Professional Divisions shall secure from the Divisions and from other standing or technical committees participating in the meeting and from the Local Committee the necessary papers for each session.

Approval of Papers by Divisions

6 Each Division or technical committee shall approve the subject matter and form of papers included on the program, and shall be responsible for the development of discussion thereof.

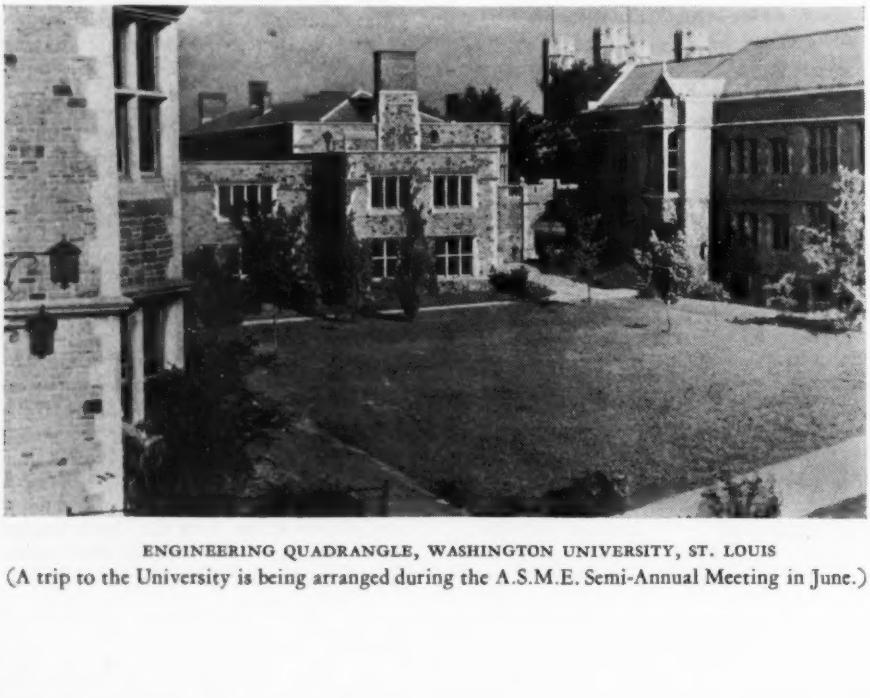
7 Each technical paper for the program must be submitted to the Division or Committee responsible three months prior to the scheduled date of the meeting in order to provide for prepublication.

8 The paper should be submitted in duplicate either to the chairman or secretary of the Division or to the Secretary of the Society. In those cases where it is submitted to the Division a copy of letter of transmittal should be sent to the Secretary of the Society.

New Plan to Aid Members

9 The Committee on Professional Divisions in planning for future National Meetings of the Society is urged to provide comprehensive programs of high caliber in order to provide an outlet for some of the congestion now apparent at the Annual Meeting, and to improve the contact of the Society with members who are unable to attend the Annual Meeting.

10 The Committee on Professional Divisions shall suggest names of the presiding chairman for each session. Upon approval by Committee on Meetings and Program they shall officially be appointed by a letter from the President of the Society.



ENGINEERING QUADRANGLE, WASHINGTON UNIVERSITY, ST. LOUIS
(A trip to the University is being arranged during the A.S.M.E. Semi-Annual Meeting in June.)

A.S.M.E. Calendar

of Coming Meetings

May 10–12, 1938
Machine Shop Practice Division Meeting
Rochester, N. Y.

June 6–9, 1938
Oil and Gas Power Division Meeting
Dallas, Texas

June 20–24, 1938
Semi-Annual Meeting
St. Louis, Mo.

September 12–16, 1938
Applied Mechanics and Hydraulic Divisions Cooperating in International Congress of Applied Mechanics
Cambridge, Mass.

September 22–23, 1938
Wood Industries Division Meeting
High Point, N. C.

October, 1938
Fuels Division Meeting jointly with A.I.M.E. Coal Division
Chicago, Ill.

December 5–9, 1938
Annual Meeting
New York, N. Y.

Award for Young Mechanical Engineers Established by Pi Tau Sigma Fraternity

A.S.M.E. Awards Committee to Make Selection

It has been recognized for some years that there has been no suitable award for the young mechanical engineer for his accomplishments within ten years after graduation. As a suitable means for rewarding him, a medal for outstanding young mechanical engineers will be awarded each year, according to a plan formulated by Pi Tau Sigma and approved by the Council of The American Society of Mechanical Engineers.

Recognition Plan

The Pi Tau Sigma Recognition Plan was created to emphasize to mechanical engineers that their service to mankind is shown not only by achievements in purely technical pursuits but in a variety of other ways. It holds that an education based upon the acquisition of technical knowledge and the development of logical methods of thinking should fit the engineer to achieve substantial success in many lines of endeavor.

As evidenced by his past record and future promise, the medal shall be given annually to a young engineering graduate for meritorious service in the interests of his fellow men. It is the intent of Pi Tau Sigma that the description of the character of the contribution or contributions for which the medal may be awarded shall be liberally construed.

Conditions of Award

1 Any man of good character, who on June 1 of each year has been graduated not more than ten years from the regular mechanical-engineering course of a recognized American college or university, and is not more than 35 years of age, shall be eligible for the recognition.

2 Achievement may be all or in part in any field, including the industrial, educational, political, research, civic, and artistic. In making selections of candidates, their achievements of whatever kind will be examined for an application of basic engineering methods or principles.

Nominations

3 Nomination shall be made on the regular form provided by Pi Tau Sigma, and shall be submitted by June 1 of each year to the National Secretary of Pi Tau Sigma.

4 The following may make nominations:

a Any member, or group of members, of Pi Tau Sigma.

b Any local section of The American Society of Mechanical Engineers.

c The head of the mechanical-engineering department of any American college or university offering a regular four-year course, or its equivalent, in mechanical engineering.

d Or any other individual, or group of individuals, who in the opinion of the Board of Awards, are properly qualified to make nominations.

5 The National Secretary of Pi Tau Sigma will receive these nominations on or before before June 1 of each year; the Pi Tau Sigma Award Committee will select the ten best who, in its opinion, are the most outstanding of the nominations received. This material will be submitted to the A.S.M.E. Honors and Awards Committee for final selection of the most outstanding young mechanical engineer for that year.

6 Announcement of the engineer or engineers chosen from among the nominees by the Board of Awards will be made as soon as is consistent with a careful survey of all the candidates' credentials. The Board also reserves the right to make no selections when, in its opinion, no candidates with the necessary qualifications are presented.

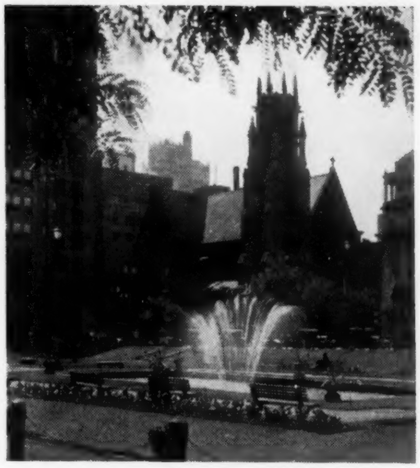
Award Given at A.S.M.E. Annual Meeting

7 The candidate selected will receive the Pi Tau Sigma gold medal with an honorarium to cover travel expenses to and from New York City. The medal will have the words "Pi Tau Sigma Award—Outstanding Achievement in Mechanical Engineering" around the front rim; the reverse side to be engraved with the name of the winner and the date of award.

8 Public announcement by the Board of Awards of the engineer chosen from among the nominees will be made at the A.S.M.E. Annual Meeting, at which time it will be necessary that the recipient be present to receive the award. Should illness, death, or other unforeseen circumstances prevent his being present, the award would be made "in absentia."

1938 Nominations

Nomination forms have been sent to the engineering schools and colleges of the United States, members of the A.S.M.E. Council, members of the A.S.M.E. Honors and Awards Committee, and to the chairman of each local section of the A.S.M.E. in order to obtain a diversity of nominations and a good geographical distribution of possible candidates. Additional blanks can be obtained from Prof. H. E. Degler, University of Texas, Austin, Texas, who is National Secretary of Pi Tau Sigma for 1938.



Courtesy St. Louis Convention Bureau

SUNKEN GARDENS IN DOWNTOWN SECTION OF ST. LOUIS

Wood Industries Division to Meet Sept. 22–23

The annual meeting of the A.S.M.E. Wood Industries Division will be held on Thursday and Friday, September 22 and 23, 1938, in High Point, N. C. with headquarters at the Hotel Sheraton.

High Point was chosen, not only because of its central location in the southern furniture-manufacturing industries, but also because the cost and production division of the Southern Furniture Manufacturing Association is to hold a meeting at the same place on Wednesday, September 21.

The program and inspection tours are being arranged to encourage members of both divisions to attend for the three days. The Pacific Coast woodworking industries will be represented on the program, further details of which will be given in later issues.

Actions of A.S.M.E. Executive Committee

In the absence of Harvey N. Davis, president, who had left for the Pacific Coast to attend the 1938 National Spring Meeting of The American Society of Mechanical Engineers at Los Angeles, Calif., James M. Todd, vice-chairman, presided at the March 18 meeting of the Executive Committee of the A.S.M.E. Council, held in New York at Society headquarters. Others present were Harte Cooke, James W. Parker, and Kenneth H. Condit, of the committee; K. M. Irwin (Finance), and J. N. Landis (Local Sections), advisory members; and C. E. Davies, secretary. Actions of general interest taken by the committee are as follows:

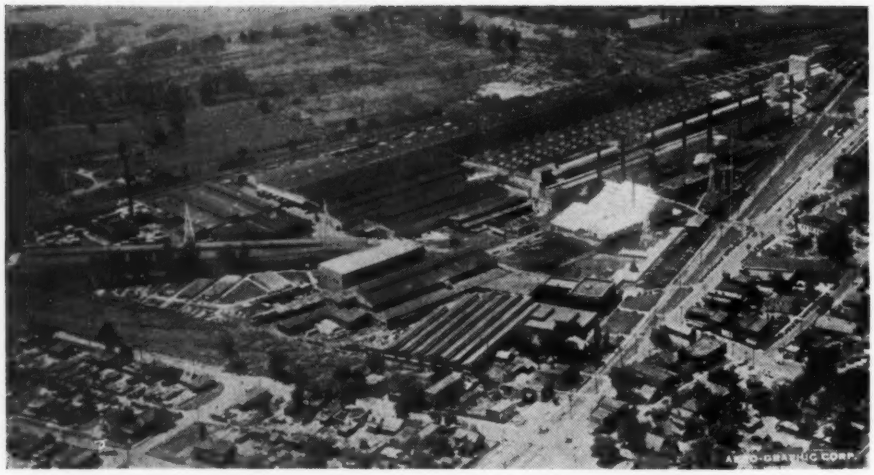
Approval was voted of a statement "Procedure for Planning the National Meetings of the Society," the text of which will be found on page 438 of this issue.

An Oil Metering Conference, under the auspices of the Petroleum Division, to be held at Norman, Okla., was approved.

Appointments

The following appointments of Society representatives were reported:

Committee on Thermal Insulating Materials, A.S.T.M., R. H. Heilman; E.C.P.D. delegatory committee, region IV, E. B. Norris; Fifth International Congress of Applied Mechanics, Cambridge, Mass., September, 1938, C. R. Soderberg and R. Eksergian, chairman and secretary, respectively, Applied Mechanics



PLANT OF OWENS-ILLINOIS GLASS COMPANY AT ST. LOUIS
(An excursion is being arranged to this plant during the A.S.M.E. Semi-Annual Meeting in June.)

Division; Louisiana State University, group conferences on higher education and dedication of new buildings, Baton Rouge, La., April 6 to 8, 1938, James M. Todd.

Record was made of the approval, by letter ballot, for adoption as a standard practice of the Society, of the second revised edition of API-ASME Code for Design, Construction, Inspection, and Repair of Unfired Pressure Vessels for Petroleum Liquids and Gases, and of the Council approval, by letter ballot, of the adoption as standards of the Society of "Extra Light Series Annular Bearings," and revisions to "Wide Type Annular Bearings."

Valuable Program Planned for Oil and Gas Power Conference, Tex., June 6–9

THE NATIONAL Oil and Gas Power Conference, the big yearly occasion in the affairs of the Oil and Gas Power Division of the A.S.M.E., is scheduled for June 6 to 9, inclusive, at the Hotel Baker, Dallas, Texas.

The technical program is not completely defined at this date but it is definite that there will be papers on Diesel streamline trains, Diesel automotive practice, the latest information on fuel-oil specifications, operating results with 2-cycle Diesel gas engines, modern practice in hydraulic governing, the latest information on vibration insulation, modern lightweight Diesel-engine construction, a new indicator design, gas-engine–gas-compressor practice, the maintenance of Diesel engines, and Diesel economics. These subjects will be discussed by authorities in the respective fields.

Arrangements are being made for the golf tournament and banquet which those in attendance at Oil and Gas Power Conferences have come to expect as high spots in Conference Week. Exhibitors are beginning to sign up already and there is every prospect for an interesting and instructive exhibit of Diesel- and gas-engine parts and accessories.

The Hotel Baker is one of the most modern hotels in this most modern City of the Southwest. It has 300 air-conditioned rooms and, in line with the policy of other Dallas hotels, prices will be reasonable and definitely not increased because of this occasion. The room which is being provided for the sessions will also be air-conditioned.

The Oil and Gas Power Division has adopted a policy of holding at least one meeting in three in the oil-country district. The last such meeting was at Tulsa, Okla., and attracted many men in the oil-production and transportation industry who normally do not go to conferences held in the East. There is every reason to believe that there will be an even larger attendance of such men at this Dallas Conference.

To Engineering Educators

Attend A.S.M.E. Semi-Annual Meeting—and then go on to the S.P.E.E.

THE dates of the A.S.M.E. Semi-Annual Meeting at St. Louis, June 20–24, have been so arranged that one may go directly from it to the S.P.E.E. Meeting, starting June 27, at the Agricultural and Mechanical College of Texas, College Station, Texas.

This suggestion is passed along to those members of the A.S.M.E. who are also members of the S.P.E.E. Perhaps they have not realized how perfectly the dates of the two meetings will fit in with their plans. There is just enough time to drive from one to the other.

Matschoss to Represent A.S.M.E. at Congress

IN RESPONSE to an invitation from the International Bureau for Technical Education for a representative of the A.S.M.E. to attend the International Congress for Technical Education in Berlin, July 25–29, 1938, President Harvey N. Davis appointed Dr. Conrad Matschoss of Germany as Honorary Vice-President of the Society for the occasion.

News of Committees

Correction of Forming-Tool Standard

SINCE the publication of the American Standard on Circular and Dovetail Forming Tool Blanks, the committee responsible for the standard has recommended the following corrections and additions: *Page 6:* Table 2. In group 3 change the number of threads in column C to read $^5/_8$-11, instead of 12 threads. *Page 7:* Add footnote to the effect that the tolerance on the diameter of the bolt hole "C" is +0.003 and −0.000 in. *Page 8:* Table 4. In group 5 change the designation of the fourth blank from 3 × 4 to 5 × 4. Add the following footnotes: The tolerance on the width of dovetail measured across plugs "F" is +0.003 and −0.003 in. The tolerance on the width of adjusting slot "H" is +0.003 and −0.000 in.

Radiographic Testing Committee

In order to carry out more effectively important work in the field of radiographic testing, there has been organized a new A.S.T.M. Committee for Radiographic Testing. It was formally organized on February 14 and held a meeting in Rochester during the week of March 7. In the long list of committee members the names of C. A. Adams and G. F. Jenks, members, A.S.M.E., are noted. A great deal of preliminary work in this field has already been done by the A.S.M.E. Boiler Code Committee.

Woman's Auxiliary Meets

"HOBBIES" held sway at the Thursday afternoon, April 14, meeting of the Woman's Auxiliary to the A.S.M.E., in the garden rooms of the Woman's Clubhouse at Wanamaker's, New York.

The program opened with a piano duet by the president of the Auxiliary, Mrs. G. W. Farney, and a past-president, Mrs. G. L. Knight Mrs. R. V. Wright, also a past-president, spoke of her spare-time hobby, patch-work quilts, showing a most attractive one. Mrs. Otis Hovey's hobby is hooked rugs and her exhibit was most striking. Mrs. F. M. Gibson interested her audience in her collection of glass-work. A guest, Mrs. Herbert Spencer, delighted all with her violin solos and another guest, Miss Hau Pala, in costume, illustrated her talk with dolls dressed in various Hawaiian costumes. Mrs. Mary Lewis of the National Doll and Toy Collectors' Club showed dolls dressed as brides and bridegrooms of foreign countries. Mrs. M. Carbone brought the program to a close with a talk on her many matched sets of beautiful jewels.

Peninsula Section Helps Arrange Program for 58th Annual Convention of Michigan Engineers

James W. Parker and L. W. Wallace are Among Speakers; Dean H. B. Dirks Elected President of M.E.S.

MORE THAN 275 engineers attended the 58th Annual Convention of the Michigan Engineering Society held in Grand Rapids, Mich., April 7 to 9, under the joint sponsorship of the Peninsula Section, A.S.M.E., and the Grand Rapids Engineers' Club. Following the opening address by the president of the society on Thursday afternoon, James W. Parker, manager of the A.S.M.E., talked on "The Nation's Capacity for Self-Control." The speaker at the banquet on Friday evening was L. W. Wallace, vice-president of the A.S.M.E., who spoke on "The Engineer and Civilization."

At the business meeting which opened Friday's program, the Michigan Engineering Society elected the following officers: President, Dean Henry B. Dirks, member, A.S.M.E.; vice-president, E. R. Weeber; secretary, V. B. Steinbaugh; treasurer, Bruce Buchanan; director, John Hartman; and executive secretary, E. L. Brandt. What the profession is seeking to do for the nation, through the American Engineering Council, was told to the assembled engineers at the afternoon session by Frederick M. Feiker, executive secretary of the Council.

Parker Gives Ideas on Government

Mr. Parker, in his speech, suggested that perhaps the English form of government was in some ways superior to ours since it did not separate so thoroughly the function of an executive and of legislature. However, he made it plain that it was not his intention to advocate that the chief executive should dominate the legislation but that it might be highly advisable for the chief executive to lead the legislature. He also pointed out that the decentralization of authority has been found desirable in large private industry and that he could not help but feel that the same would be advantageous to the nation and its government.

Wallace on Engineer's Public Duty

In his talk, Mr. Wallace stated that the engineer can ill afford to shirk his responsibility as a creative force in the world of things and as a potent influence in the realm of human intercourse. Some of the engineer's ability, according to him, should be diverted to the study of ways and means of repairing and improving the human machine, thus creating a better civilization.

Illness Keeps Dean Cooley Away

Dean Mortimer E. Cooley, honorary member, A.S.M.E., who had promised to act as toastmaster at Friday's luncheon, was forced to stay away at the last minute on account of illness. Another who could not attend because of sickness, was Dean H. C. Anderson, member, A.S.M.E., and chairman of the Michigan Engineers' Registration Board. Therefore his talk on the new Michigan registration law was given in his stead by Prof. C. T. Olmstead, secretary of the board. The talk showed how the law follows closely the model, drafted and sponsored by the A.S.M.E. and other engineering societies.

Connecticut Local Sections Conduct Joint Affairs

NEW BRITAIN SECTION acted as host at a joint meeting with the Hartford, Waterbury, Bridgeport, New Haven, and Norwich Sections at the Endee Club in Bristol, Conn., April 6. Ralph E. Flanders, past-president of the A.S.M.E., talked on the subject of "Engineering Economics."

The Annual Spring Meeting and Outing of the Connecticut Local Sections of the A.S.M.E. will be held at the New Haven Lawn Club in New Haven, Conn., May 11, 1938. Further information may be obtained from the secretaries of the local sections participating in this affair. Some of the events scheduled may be found on page 458 of this issue under the Calendar of Local Sections Meetings.

Other Local Sections News

Akron-Canton

A trip was made to the Hercules Motors Corp. in Canton, Ohio, by the members and their guests. Following dinner at the Elks Club, a lecture on gasoline and Diesel engines was given by O. D. Treiber, member, A.S.M.E.

Anthracite-Lehigh Valley

Meeting in Easton, Pa., on March 25, the section opened the meeting with a few remarks from C. E. Davies, secretary of the A.S.M.E., following which a symposium on mechanical developments in the steel industry in the Lehigh Valley was conducted. Prof. B. H. Jennings read a paper by Prof. F. V. Larkin entitled, "History of the Iron Industry in Bucks, Northampton, and Lehigh Counties." Joseph H. Morrow gave a paper about "The Iron Industry at Catasauqua, Hokendaugua and Fullerton." Prof. P. B. Eaton read a paper on "The Durham Furnace," based on material collected by B. F. Fackenthal. Other speakers included Charles E. Lehr, H. T. Morris, E. F. Martin, and Paul Hoffman.

Atlanta

About 50 members turned out on April 4 at the Atlanta Athletic Club to listen to Geo. A. Orrok, honorary member of the A.S.M.E., trace the latest developments in power-plant design. On March 28, Earl W. Lawrence gave an illustrated talk on ball and roller bearings, their characteristics and application.

Baltimore

Railroading with modern power was the subject of the talk given by W. M. Guynes, General Electric Co., before the section at the Engineers' Club of Baltimore.

Bridgeport

Under the auspices of the Engineers' Club and the Bridgeport Section, A.S.M.E., Dr. Phillips Thomas related his "Adventures in Electricity," before a large audience assembled in the auditorium of Central High School on March 14.

Central Indiana

Military affairs were discussed at a meeting of the section in Anderson, Indiana, at which Lieut. Col. W. D. Critenberger of the U. S. Army was the chief speaker.

Cincinnati

At the March meeting, E. G. Bailey, vice-president, Babcock & Wilcox Co., gave a talk on "The Design and Operation of Modern High-Pressure High-Temperature Steam Boilers." Starting at 4 o'clock in the afternoon of April 21, members of the Engineers' Club and the Cincinnati Section, A.S.M.E., made an inspection tour through the plant of The Cincinnati Milling Machine Co. where they had an opportunity to see in operation milling and grinding machines which utilize hydraulics for feeding, tracing and profiling mechanisms. Following a dinner in the company dining room, the members assembled in the plant auditorium to listen to a talk on "Hydraulic Applications in Machine Tool Practice," by Hans Ernst, research director of the company and member, A.S.M.E.

Chicago

Talking before the Chicago Section recently, L. W. Wallace, vice-president, A.S.M.E., in his paper on "Industrial Research" classified research under three types, namely, fundamental, creative, and applied. The primary objective of fundamental research is to discover the basic principles underlying the universe and the circumstances of life. Creative research aims to discover, invent, or produce new materials, new processes, new equipment, or to find new uses for existing materials. Applied research determines ways and means of adapting to concrete problems the knowledge, materials, equipment, and processes made available by fundamental and creative research.

The March 31 meeting was devoted to the problems of the young engineer. C. F. Hirshfeld, member, A.S.M.E., and director of research for the Detroit Edison Company, dis-

cussed the preparation of the young engineer for his role in industry, and A. E. Holstedt, personnel manager of The Crane Co., described the system of selection and development of young engineers for industry.

Cleveland

On March 29, Thomas H. Nicholl, vice-president, Cleveland Railway Company, presented a paper on "Modern Trends in Urban Transportation."

Colorado

The entire membership, it seems, attended an inspection trip to the Coors Brewing Co. in Golden, Colorado. Prior to conducting the members through the plant, their host, Adolph Coors, Jr., treated them to a buffet lunch and beer. The inspection of the new power plant and the process machinery then followed. A meeting on March 9 featured a talk on the "Colorado–Big Thompson Project" by Porter J. Preston, senior engineer, U. S. Bureau of Reclamation.

Dayton

A successful meeting was conducted at Springfield, Ohio, March 24, under the direction of Charles L. Bauer. About 100 members took part in the afternoon trips and the evening meeting. On April 22, the members met in the Dayton Engineers' Club to discuss economic problems based on the report of Ralph E. Flanders' committee which investigated "The Balancing of Economic Forces."

Detroit

An inspection tour, dinner, and meeting, attended by 250 members and guests was held on March 15. After inspecting the new Diesel plant of the General Motors Corporation, the section held its monthly dinner at the Botsford Tavern. At the meeting which followed, F. G. Shoemaker, chief engineer, Detroit Diesel Engine Division, General Motors Corporation, described the development of the G. M. Diesel engines. The talk was illustrated by lantern slides of manufacturing methods and of unusual design features.

Dr. H. G. Moulton, president of the Brookings Institution, came from Washington, D. C., on April 20 to address a joint meeting of the Detroit Section, A.S.M.E., and the Engineering Society of Detroit held at the Detroit Institute of Arts.

Erie

Addressing a joint meeting of the Erie Section, A.S.M.E., and the local chapter of the A.I.E.E. on March 8, Charles F. Green, designing engineer, General Electric Co., talked to 104 people on the subject, "From Flying Crates to the Modern Plane." After reviewing the history of planes, Doctor Green pointed out that air transport is safe today, even though newspapers exaggerate accident figures. By way of comparison, he showed figures where seven persons were killed one weekend in a crackup, and during the same weekend, 67 people died of alcoholism in New York City, adding in a humorous way the fact that it was safer to fly than to drink alcohol.

Florida

With C. M. Lowry, chairman of the Florida section, A.S.M.E., presiding, the A.S.M.E. session of the annual meeting of the Florida Engineering Society was held the afternoon of April 21 in Jacksonville, Florida. W. A. Lawrence presented the report of the Committee on Mechanical Engineering. The increasing industrial significance of the South was the subject of a paper by Eugene W. O'Brien, past vice-president, A.S.M.E. Other papers were presented by D. G. Moon on "Pulp and Paper Processes for Southern Pine," Paul R. Yopp on "Recent Developments in Steam Generation," M. J. McWhorter on "Industrial Control Problems," and S. P. Goethe on "The Economic Possibilities of Reversed Refrigeration for Heating in Florida." W. E. Drew was in charge of the A.S.M.E. session.

Hartford

The problems relating to industrial mobilization were discussed at a meeting of the Hartford Section on March 31 by Capt. D. N. Hauseman, chief of the procurement planning section in the office of the Chief of Ordnance, U. S. Army. He showed how the Ordnance Department has established 14 district procurement offices throughout the United States. One of the offices is known as the Hartford Ordnance District and is located at Springfield Armory, Springfield, Mass.

Inland Empire

Harvey N. Davis, president of the A.S.M.E., and members affiliated with the Inland Empire Section visited the Grand Coulee Dam on the morning of April 7. In the evening, a meeting was held at which President Davis expounded his ideas on engineering and the future.

Ithaca

The Ithaca Section met with the Cornell Student Branch on March 18 to listen to Harte Cooke, vice-president of the A.S.M.E., talk briefly on Society affairs, and then discuss more fully the subject of Diesel engines.

Kansas City

Meeting at the University Club on March 22, the members of the Kansas City Section were given a résumé of the welding conference held at the University of Kansas by Prof. A. H. Sluss. Following this, slides were shown of the erection of a 200,000-sq ft building by welding.

Knoxville

An inspection trip was made by the members to the Mascot Mine on March 26. Following a trip through the mine, a meeting was held in the company's clubhouse at which C. B. Strachan discussed the mechanical problems in mining zinc.

Mid-Continent

When President Davis visited the section in the early part of March, 125 members turned out to greet him at a dinner meeting. Following are some excerpts from the report of J. H. Engelbrecht, section secretary, about the meeting: "The local boys chipped in and bought Doctor Davis an Indian head-dress, and also gave him a book of etchings of the city of Tulsa. . . . . An unusual feature never before occurring in the history of the section was the fact that three deans of engineering schools from the same state sat down at the speaker's table to discuss a common problem."

North Texas

A dinner meeting on March 14 was addressed by Harvey N. Davis, president of the A.S.M.E. In his talk he described the human engineering laboratories at Stevens Tech of which he is head. Another distinguished visitor was Eugene W. O'Brien, past vice-president, A.S.M.E. On April 11, Prof. H. E. Degler, head of the mechanical-engineering department at the University of Texas, discussed the recent developments in air conditioning.

Norwich

Following a routine business discussion, the meeting of March 18 at the Allyn Museum in New London was turned over to Prof. Z. R. Bliss, Brown University, who discussed the high lights of the recent international yacht races and some of the engineering considerations.

Ontario

St. Patrick's Day was properly celebrated at a joint dinner meeting of the Ontario Section and the local chapter of the A.S.M.E., at the Royal York Hotel. The guest speaker, A. E. Cartwright, described the properties of brass and aluminum alloys, particularly in regard to resistance to corrosion. Development of test procedures for comparison of a number of specimens under conditions closely simulating actual service requirements, such as alternate air-liquid exposure, were described. Foundry technique for the production of difficult shapes in special alloys was dealt with in full by means of illustrations. More than 180 members and guests were present.

Peoria

Aeronautical transportation was the subject of a paper given before the Peoria Section on March 10 by William Littlewood, vice-president in charge of engineering, American Airlines, Inc.

Philadelphia

The regular March meeting of the Philadelphia Section was addressed by R. G. McElwee, foundry engineer, Vanadium Corporation of America, T. D. Parker, metallurgical engineer, Climax Molybdenum Company, and J. S. Vanick, research engineer, International Nickel Company, on the subject, "The Use of Alloys in Modern Cast Iron." The papers, according to E. L. Hopping, section secretary, were extremely interesting to the 80 members who were present. The annual outing of the section on March 24 was held at the Overbrook Country Club where there was golf and other sports with dinner, entertainment, and dancing in the evening.

Providence

The scheduled speaker for the meeting of March 23 was Prof. Harold E. Edgerton,

M.I.T., whose subject was "High-Speed Movies."

Rochester

A lecture on "Diesel Engines" illustrated with slides was given at the April 12 meeting by Harte Cooke, vice-president of the Society.

St. Louis

"Use of Glass Fiber as Insulation and Textile," was the subject of a talk presented by Games Slayter, director of the laboratory, Owens-Illinois Glass Co., at the March meeting. The April meeting was devoted to an illustrated lecture on watches and watchmaking, given by L. K. Malvern of the Elgin National Watch Co.

San Francisco

Guest of honor at the March 30 meeting of the San Francisco Section was Harvey N. Davis, president of the Society. The 115 members and guests thoroughly enjoyed his brief informal talk on engineering. Prof. Lester C. Uren, professor of petroleum engineering at the University of California, presented a talk on the "Engineering Problems in the Exploitation of Deep-Seated Oil Deposits." He told of an oil well in Kern County, California, which is 14,400 ft deep. Other interesting points in his talk were that 29,000 oil wells with an aggregate depth of 93,750,000 ft were drilled last year, oil production from 365,000 operating wells in this country was about one and a quarter billion barrels, and cost of drilling in the Kettleman Hills field is about $20 to $25 per foot.

South Texas

The April meeting of the South Texas Section was held at Rice Institute in Houston, Texas. A. W. Allison, Jr., one of the members who is connected with the Champion Fibre and Paper Company, read a paper on "The Manufacture of Pulp and Paper." The talk was illustrated by means of a drawing of a pulp and paper plant. Samples of the products at various stages of manufacture were shown.

Susquehanna

"Vibration, Its Balance and Isolation," was the subject of a paper presented by Emil T. Neubauer at a meeting of the section on March 21.

Syracuse

At its St. Patrick's Day meeting, the Syracuse Section was given a short talk on the history and development of "Modern Tool Steel" and their applications by Robert Warren, metallurgist, Crucible Steel Co. of America. This was followed by a moving picture showing the manufacture of tool steels.

Washington, D. C.

More than 200 members and guests turned out on March 10 to hear Vesper A. Schlenker discuss the fundamentals of noise and vibration problems. He explained the decibel scale and pointed out the pitfalls in its use for evaluating the performance of ventilating systems. Also covered in the talk were methods of noise absorption and isolation.

West Virginia

The March 28 meeting held in Charleston, W. Va., was attended by 70 members and guests. One speaker, James P. Stewart, explained the theory and practical application of centrifugal blowers. Another, M. T. Davis, Jr., a junior member, discussed the recent developments in high-strength cast iron.

Western Washington

About 100 members and guests attended the March 10 meeting of the section in Seattle, Wash. Eugene A. White, manager of the Tacoma Smelter Co., talked on "The Metal-Mining Industry of the State of Washington," George W. Evans, consulting engineer, described "The Coal Mining Industry of the State of Washington," and Prof. Hewitt Wilson, of the University of Washington, lectured on "Non-Metallic Minerals of the State of Washington."

Worcester

Following a dinner, members of Worcester Section met at Worcester Polytechnic Institute on March 10 to hear Waldo Guild speak on hydraulic control of machinery.

Junior Group Activities

First Cooperative Paper by Detroit Group

THE FIRST of a series of cooperative papers was heard by the Detroit Junior Group at a dinner meeting at the Café Old Madrid, on March 29. After Dean C. J. Freund had read parts of a letter from a former graduate of the University of Detroit, F. A. Jennings, a Detroit Junior, presented the cooperative paper prepared by the Manufacturing Division under the guidance of Klass Knibbe. W. B. Oakley, D. J. MacGillis, S. F. Patyrak, and F. A. Jennings contributed the material on which the paper was based.

Dealing with the general subject "The Junior Engineer in Industry," the paper treated the specific problems confronting a young engineer in a large manufacturing plant. It explained how the production worker feels toward his job and management, how the young engineer becomes acccustomed to his work, and the experience he gains on the assembly line. Problems of employer-employee relationships were also discussed. An active discussion indicated the general interest in the paper.

This presentation marked the start of the Detroit Group's program of cooperative papers, described in a previous issue. Briefly, a group of Juniors, with some common interest, work together to produce a cooperative paper, on a subject in their field. The success of this first paper was gratifying to the Executive Committee who devised the plan, and to those who took part in the program. Next month another group will present a paper on air conditioning.

Gas Engines Discussed by Baltimore Group

THE JUNIOR Group of the Baltimore Section held its third meeting of the second half of the 1937–1938 season on April 6, at Johns Hopkins University. William P. Hill, general foreman of the gas-engine department of the Sparrows Point, Md., works of the Bethlehem Steel Company, spoke on "Power Generation by Means of Gas Engine Drive." He discussed present-day practice in layout and construction, engine characteristics, operation, and heat balance. The talk also brought to the Juniors information on latest developments in the field of power generation by gas engine.

The Baltimore Group now has a close neighbor in the newly formed Washington, D. C., Group, and is cooperating in every way with this embryo organization. Suggestions, based on past experience, are being offered, arrangements have already been made for a joint field trip, and exchange trips between Washington and Baltimore are also planned. To stimulate interest in both groups, joint meetings and competitive papers are being considered.

Cleveland Juniors Meet With Case Students

THE ANNUAL Joint Meeting of the Student Branch at Case School of Applied Science and the Cleveland Section was held at the Case Club on Tuesday, March 29. Dinner was served to 57 members of the Society, including Juniors and students. By the draw of a card, one person won a free meal.

The meeting, presided over by William Seaver, chairman of the Student Branch, was held in the clubroom, immediately after dinner. Thomas H. Nicholl, vice-president in charge of equipment, Cleveland Railway Co., struck a responsive note with his talk on "Modern Trends in Urban Transportation," which was followed by a lively discussion.

Outlining the problems of mass transportation which face transit companies today and the steps taken to meet them, Mr. Nicholl told of the introduction of new and improved types of vehicles, including the Presidents' Conference Committee trolley car. This car, the result of intensive research, embodies many unique construction features, and has met with marked success in several cities. Wheels are rendered practically noiseless by

an ingenious rubber mounting between the journal and the rim. These cars will accelerate at a maximum rate of 4.75 miles per hr per sec, as compared with a rate of about 2.5 for cars of older types. Maximum acceleration is reached in a series of small increments which eliminates that equilibrium-destroying jerk so annoying to passengers.

Following this talk, a sound movie showing the part electricity is playing in modern transportation was presented, prefaced by a few remarks by Mr. Thirwall of the transportation-engineering department of the General Electric Co. He stated that their experience showed the choice of one of the three vehicle types available to be dependent on the density of traffic. Thus, the P.C.C. car handles high-density traffic economically; for medium density, the trackless trolley proves adequate; while the motorbus seems the solution of the low-density problem.

Ernest Hartford Talks to Kansas City Juniors

ERNEST HARTFORD, assistant secretary of the A.S.M.E., was guest speaker at the regular meeting of the Kansas City Junior Group, held March 8 in the Kansas City Power and Light Building.

Mr. Hartford's considerable experience with Junior organizations made his talk highly interesting and valuable to the listening group. A number of suggestions offered for the improvement of the organization were enthusiastically received. Mr. Hartford also told of the work being done by other junior organizations.

"The Extension of Employment by Creation of New Markets in the Can Industry" was discussed by Burton Hazelton of the Junior Group. Messrs. Neal, Smith, McDonald, Stone, and Maillard of the Kansas City Section were present, as were Professor Helander and Messrs. Deffenbaugh and Shephard, chairman and secretary of the Kansas State Student Branch, respectively.

Sewage-Disposal Plant Described at Tri-City

THE REGULAR March meeting of the Tri-City Junior Group was featured by a discussion of "The Milwaukee Sewage-Disposal Plant" by E. Winholt, power engineer, Deere and Co. After the introduction by Chairman Hand, the speaker launched into a description of the plant, illustrated by a chart.

The plant handles an average of 85,000,000 gallons of water per day. Storm water is kept separate from sewage as much as possible and not treated. Annual cost of operating the plant is approximately $1,000,000, of which $500,000 is secured through the sale of fertilizer at the plant.

Consideration was given to the local sewage-disposal problem as well. Mr. Winholt pointed out that the State of Illinois is forcing cities along the Rock River to build disposal plants and to stop dumping untreated sewage in the river. Rock Island is the only local city that will be affected by this since Moline, East Moline, and Silvis dump their sewage into the Mississippi. In Mr. Winholt's opinion, the problem could be solved best by each city's building its own treatment plant rather than by organizing a central sanitary district, carrying all sewage below Rock Island for treatment. This plan would have a lower initial cost and would place the responsibility of management directly on each municipality.

Junior-Student Meeting Features Metro Program

THE ANNUAL spring joint meeting of the junior and student members of the New York area was held at the Engineering Societies Building on April 1. Principal speaker was Dr. Walter Rautenstrauch of the Industrial Engineering Department, Columbia University.

The subject was "The Social Responsibility of the Engineer," and Dr. Rautenstrauch brought all his broad experience and wide knowledge of current affairs to the presentation. General discussion followed.

Reports were made by representatives of each of the student branches present, including New York University, City College, Pratt Institute, Brooklyn Poly, Cooper Union, Stevens Tech, and Newark College of Engineering. Columbia University assisted in preparations for the meeting.

The meeting closed with an exhibition fencing match in which Newark College of Engineering defeated Cooper Union in all five contests. Many of the students and juniors remained after all the scheduled events had been run off in order to renew old acquaintances and make new ones.

The program was arranged by H. G. Oliver, Jr., and R. T. Haggerty, assisted by F. W. Fiala, Pratt; R. E. Denzler, Stevens; B. Jaffe, Columbia; A. Matiuk, Cooper Union; F. B. Northrup, Jr., Newark College of Engineering; D. F. Ritterbusch, Brooklyn Poly; R. Robertson and P. Scheuble, Jr., City College. H. G. Oliver, Jr., presided.

Air Conditioning

B. F. Carter, commercial engineer in the air-conditioning department of the General Electric Company, spoke on "Residential Air Conditioning" at the April 13 meeting of the Air-Conditioning Seminar. The May meeting of the Seminar will be featured by a paper on "Cooling Towers" by S. P. Brown of the Research Corporation.

National Defense

Lieutenant Deutschmann led the April 6, Army Day, meeting of the National Defense Seminar. The subject was "The Cooperation of Observation Aviation with Ground Troops" and the principal speaker was Lieut. G. H. Wenn of the Air Corps, New York National Guard. The annual inspection trip will be held in May.

Meeting With Hydraulic Division

"High-Pressure Centrifugal Pumps for Boiler Feed Service" were discussed at the April 5 meeting of the Hydraulic Division of the Metropolitan Section, sponsored jointly by the division and the Junior Group. Latest developments in the field were presented by such authorities as M. Spillman, consulting engineer, Worthington Pump and Machinery Corporation; Arvid Peterson, chief engineer, DeLaval Co.; and Dr. Joseph Lichtenstein, Foster Wheeler Co. The meeting was in charge of P. T. Onderdonk and R. F. Warner, Jr., and the chairman was Philip W. Swain, editor of *Power*.

New Plan Tried

Metro Juniors have been divided into a large number of small units. The members of each unit are men who have indicated their interest in Junior activities by answering the annual survey form. Each group of four or five, selected by geographical location, will be headed by a leader. Several days before each meeting, the leader will get in touch with members of his unit, by telephone or mail, reminding them of the coming event and inquiring if they plan to attend. This plan will increase acquaintance among members and stimulate interest in, and attendance at, meetings.

Fuels Meeting in Chicago October 13–14, 1938

A FUELS MEETING, under the joint sponsorship of the Fuels Division of the A.S.M.E., the Coal Division of the A.I.M.E., and the Western Society of Engineers, will be held Oct. 13–14, 1938, at the Palmer House in Chicago.

THE ST. LOUIS PLANT OF THE FISHER BODY PLANT

(An excursion is being planned to this plant for the members of the A.S.M.E. and their guests attending the St. Louis Semi-Annual Meeting in June.)

With the Student Branches

Student Members Close Active Year With 119 Branches and Membership of 5222

Student Meetings in Northwest and South Feature 28 Papers, Prizes Worth $230 and Souvenirs

STUDENT BRANCHES of The American Society of Mechanical Engineers, numbering 117, closed a very successful school year with all-time record membership of 5222, 707 more than last year, according to latest figures. The year saw the formation and recognition by the Society of three new branches, namely, those at the University of Maryland, University of Arizona, and University of British Columbia. If the separate divisions of student branches at N. Y. U., Brooklyn Poly, and the University of Colorado are counted, there are actually 120 separate student groups functioning today.

Purdue, by increasing its membership from 125 to 181, beat the University of Michigan with 167 members for the honor of having the largest student branch in the A.S.M.E. Other schools with memberships of 100 or more are Armour 119, Brooklyn Poly 101, California 165, Illinois 107, M. I. T. 110, Newark, 100, N. Y. U. 118, and Pratt 117. Two schools which deserve honorable mention for membership gains are Alabama Poly (Auburn), which more than doubled its membership from 26 to 53, and Texas A. & M. College with an increase from 40 to 78.

Southern Meeting Has 9 Prizes

With Texas A. & M. College Branch acting as host, approximately 140 visitors and student members from branches at Arkansas, New Mexico, Oklahoma, Oklahoma A. & M., Rice, Southern Methodist, Texas Tech, and Texas, took part in the Southern Student Meeting held on the campus at College Station, Texas, March 28 and 29. Representatives from each of the participating schools presented 17 papers in competition for nine prizes which included cash, handbooks, and slide rules. The successful contestants in order of winning were: Lester Mueller, Texas Tech; W. A. Romine, Oklahoma; R. E. White, Texas A. & M.; K. W. McLoad, Arkansas; R. J. Bodemüller, Texas; L. T. Wright, Texas; Richard Ducker, Oklahoma; B. R. Miller, New Mexico; and L. J. Powers, Texas Tech. Lester Mueller, who was the last speaker on the program, won first prize with his paper on using "Cotton Burrs as an Insulating Material." The banquet, which was attended by 240, featured as guest speaker, Colonel W. B. Tuttle, oldest Texas member in point of service of the A.S.M.E. Other guests at the various functions included Dean Gibb Gilchrist of Texas A. & M., Prof. H. E. Degler of the University of Texas, J. H. Engelbrecht of Tulsa, and E. W. Burbank, senior councilor of the Society.

Northwest Meeting Big Success

More than 125 student members assembled at the University of Washington for the Northwest Student Meeting, April 4, 5, and 6. Participating student branches were British Columbia, Idaho, Montana State, Oregon State, Washington State, and Washington, which acted as host. At the technical sessions, there were eleven papers presented by the student representatives of the various student branches. The titles and authors of the five prize-winning papers in the order of selection by the judges were: "Determination of Torsion-Stress Concentration" by Ivan A. Shirk, Washington State; "Differentiation of the Stress-Strain Diagram," by Robert R. Henderson, Washington; "Experimental Check on Gas Engine Flywheel Theory," by Bernard Carlson, Montana State; "Limiting Size of Airplanes," by Robert E. Hage, Washington; and "Development of Low-Cost Irrigation Pumps," by Paul Harrer, Montana State.

At the banquet which followed, Lee Paul Sieg, president of the University of Washington, welcomed the visitors and Harvey N. Davis, president of the A.S.M.E., discussed the future of engineering.

At both of the Student Meetings reported above, souvenirs were distributed by various industrial firms. At the time of going to press, reports from the other eight Student Meetings were not available.

Branch News

Alabama Honors St. Patrick Too

UNFORTUNATELY, because of lack of information, your branch news editor forgot to mention in his St. Patrick article last month that Alabama Branch also honors the patron saint of mechanical engineers. Thanks to S. D. Moxley, '22, member A.S.M.E., and assistant to the president of the American Cast Iron Pipe Co., for his letter calling our attention to the omission.

Alabama Poly Branch, which prefers to be called the Auburn Branch, was entertained with a talk and demonstration by Prof. C. R. Hixon on cameras and picture taking. We wonder if Professor Hixon would send us some of his photographs of engineering interest for publication in Mechanical Engineering?

Arizona Welcomes President Davis

At a luncheon attended by most of the members, President Atkinson, Dean Butler, Major Hallett, and Dean Sackett of Penn State, Arizona Branch welcomed Harvey N. Davis, president of the A.S.M.E. It was voted at a previous meeting to make a trip to Superior to inspect the mines, mill, and smelter on April 10. Then the meeting was adjourned to the ball field to allow the branch team to practice for the interclub games on Engineers' Day.

British Columbia Branch, our newest student branch, reports a membership of 29. If present enthusiasm is any indication, the boys will do much to spread the A.S.M.E. good-fellowship and spirit throughout western Canada. Good luck to you.

Brooklyn Poly Branch has requested

AT THE STUDENT BRANCH CONFERENCE IN SEATTLE, WASH., APRIL, 5

(Left to right: Prof. R. H. G. Edmonds, honorary chairman, University of Washington, Student Branch; Prof. F. K. Kirsten, aeronautical engineering department, and Prof. E. O. Eastwood, head of mechanical engineering department, University of Washington; Dr. Harvey N. Davis, President, A.S.M.E.; E. A. Loew, dean of engineering, University of Washington; Major B. Cruickshank, a member of the A.S.M.E. for 49 years and an officer in the Western Washington Section; Robert L. Rockwell, chairman of the judges' committee; and Arden M. Scroggs, Chairman of the Student Branch at the University of Washington.)

SOME OF THE DELEGATES AND GUESTS AT THE NORTHWEST UNIT STUDENT GROUP MEETING, SEATTLE, WASH., APRIL 5, 1938

some of the members to prepare short talks for presentation at future meetings. Members Olson and Albrecht volunteered to make signs to advertise a joint meeting with the Metro Section Junior Group.

BUCKNELL BRANCH members listened to a technical discussion by N. J. Conner, Babcock & Wilcox Co., on the construction of the penstocks, valves, etc., for Boulder Dam. The actual construction of the dam was illustrated with motion pictures.

California Members Present Papers

CALIFORNIA BRANCH heard research papers presented by student members. The results of a series of tests on an evaporative air conditioner were presented in a paper by A. L. Stanly. "Modified Venturi Meter Sections" was the title of a paper presented by W. Yallalee in which he described the use of venturi sections for water measurement in irrigation systems where low head loss is necessary.

CALIFORNIA TECH BRANCH was host to the student members of the A.I.E.E., A.I.Ch.E., and A.S.C.E. at a meeting which featured the sound motion picture about "Heat and Its Control," provided by Johns-Manville.

200 Attend C.C.N.Y. Meeting

With 50 members and 150 guests present, C.C.N.Y. BRANCH welcomed Lillian M. Gilbreth, member, A.S.M.E., and consulting time-and-motion-study engineer. She spoke on the practical applications of time and motion study, and supplemented her talk with motion pictures illustrating these applications. The St. Patrick's Day meeting was held jointly with the A.S.C.E. chapter and had P. A. Wildman as guest speaker. He spoke on the construction, properties, and practical applications of gyroscopes.

COLORADO BRANCH members heard F. H. Prouty, member, A.S.M.E., on the subject of engineering appraisals.

COLORADO STATE BRANCH learned about the operations of an automobile assembly plant from Rolland Walker.

Cooper Union Night Owls Meet

Night-school members of the COOPER UNION BRANCH had one of their fellow members, Paul Weber, repeat a talk on the photo-offset process which he had presented previously before the day-school members. Another night owl, Sam Guzzardi, delivered a paper on steam boilers in which he brought out the fact that the Stirling boiler was developed by Allan Stirling, a graduate of Cooper Union.

CORNELL BRANCH members and guests, numbering 85, were privileged to have Harte Cooke, vice-president of the A.S.M.E., speak on "Diesel Engine Development." At another meeting, Warren Jones gave an illustrated lecture on modern gear cutting, and Henry C. Day talked on hydraulic mechanisms.

Florida Awards $10 in Prizes

Prizes of $5, $3, and $2, each, were awarded to C. R. Pearson, Ed E. Bisson, and G. E. Remp, respectively, for their papers given at a meeting of the FLORIDA BRANCH. Pearson will present his paper on "Refrigeration of Produce Carriers" before the Student Meeting in Atlanta. Bisson has been invited by the Florida Section, A.S.M.E., to give his paper on abrasives before the Florida Engineering Society on April 21.

JOHNS HOPKINS BRANCH in a joint meeting with the A.I.E.E. student group had the practical phases of modern engineering explained to them by Frank T. Leilich, member, A.S.M.E.

ILLINOIS BRANCH had an evening well attended despite bad weather. Members who braved the storm were well repaid by viewing an interesting sound motion picture, entitled, "Flow."

Vibrations Versus Dish Washing at Iowa

To select a candidate for representing IOWA BRANCH at the Student Meeting in Milwaukee, a meeting was held at which R. W. Lortz gave a paper on "Automobile Engine Vibrations," and J. L. Kehre spoke on "Time and Motion Study Applied to Washing Dishes." The student judges called it a tie and gave the two men ten days to improve their papers. Again the committee could not reach a decision. So finally ten members of the faculty were called in as judges at a third presentation of the two papers. Kehre finally won by the close score of 1039 to 1013 points.

IOWA STATE COLLEGE BRANCH members were encouraged to present papers at the March 30th meeting. The author of the best one is to have all his trip expenses paid to the Student Meeting in Milwaukee. The second winner is to get a paid-up junior membership in the A.S.M.E. and the third winner will receive $5 in cash. Besides the prizes, the second and third winners are to present their papers again at the Tri-Cities Section meeting in Cedar Rapids to be held late in April.

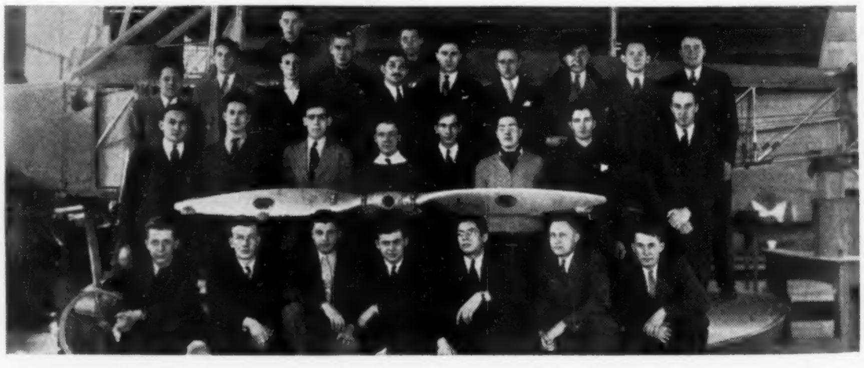
KANSAS BRANCH members listened to papers given by Harold Etchen on "Engineering Equipment for the U.S.S. *Arkansas*," Guy Bixby on "Plastics," and Alan Ayres on "The Dry-Ice Industry."

KENTUCKY BRANCH had 55 members present at a meeting where plans for attending the Student Meeting in Atlanta were discussed.

LOUISVILLE BRANCH reports that John H. Blunk discussed the working of a movable electric sign, R. L. Dupps described the new boiler of the Louisville Gas and Electric Co., and C. Haysley talked about a new brine tank at a local packing company.

Maryland Branch Installed in A.S.M.E.

On the evening of Feb. 23, 1938, at a dinner in the dining hall of the University, the UNIVERSITY OF MARYLAND STUDENT BRANCH of the A.S.M.E. was formally inducted into the Society. Dean Steinberg, toastmaster for the occasion, introduced Dr. Harvey N. Davis, president of the A.S.M.E., who talked about "The Engineer of the Future." Then the following A.S.M.E. members were introduced: A. G. Christie and F. W. Kouwenhoven from JOHNS HOPKINS UNIVERSITY; Dean A. J. Scullen, M. E. Weschler, and W. R. Scott (student branch chairman) of CATHOLIC UNIVERSITY; Dean J. R. Lapham, B. C. Cruickshanks, and



MEMBERS OF N.Y.U. (AERONAUTICAL DIVISION) BRANCH SHOWN IN THE AIRCRAFT LABORATORY

(Under the hub of the propeller is Herb Zinberg, chairman; to his left is Sidney Wishnitz, vice-chairman; and to his right is Eli Newberger, secretary.)

L. W. Froyd (student branch chairman) of George Washington University; F. V. Larkin from Lehigh University; R. C. Dannettel (chairman), F. A. Allner, F. T. Leilich, E. E. Hammond, and J. H. Mitchell of the Baltimore Section, A.S.M.E.; J. F. Fox (chairman), M. X. Wilberding, H. C. Dickinson, and H. N. Eaton of the Washington Section, A.S.M.E.; and F. M. Feiker, executive secretary of the American Engineering Council.

Marquette Branch held its annual banquet in the Stratford Arms Hotel in Milwaukee. Short talks were given by Dean Franz A. Kartak, Rev. Fr. Joseph Carroll, regent of the engineering school, and Prof. John E. Schoen, honorary chairman of the student branch. The address of the evening was given by Dr. Edgar End of the medical school, who told of the experiments he had carried on with Max Nohl in developing a new type of diving suit. Instead of the usual air lines, a nitrogen and oxygen apparatus is attached to the rear of the suit. Nitrogen has been found very useful in deep diving because of its ability to prevent "bends."

NEWARK BRANCH MEMBERS LOOKING NICE FOR THE PHOTOGRAPHER DURING ANNUAL FATHER AND SON SMOKER

(Prof. W. D. Carvin is in the front row with a light suit and a genial smile.)

100 at Michigan Meeting

About 100 members of Michigan Branch attended a meeting at which the sound motion picture, "Heat and Its Control," was shown. "The Importance of Precision Instruments to Industrial Processes" was the title of the paper by Donald P. Eckman which helped him win the honor of representing the branch at the Student Meeting in Milwaukee. It is expected that a large delegation of his fellow members will be on hand to hear him give his paper.

Michigan State Branch is again having its meetings conducted by its chairman, Joseph Brundage, who is just about able to get around on his crutches. While playing in a basketball game, Joe fell and broke his leg. However, much as he wanted to go, he had to miss the trip which the other members made to the Cadillac Motor Car Company plant.

Michigan Tech Branch selected Ernest Klepetko for his paper on "More Speed for Outboard Motors" to represent it at Milwaukee.

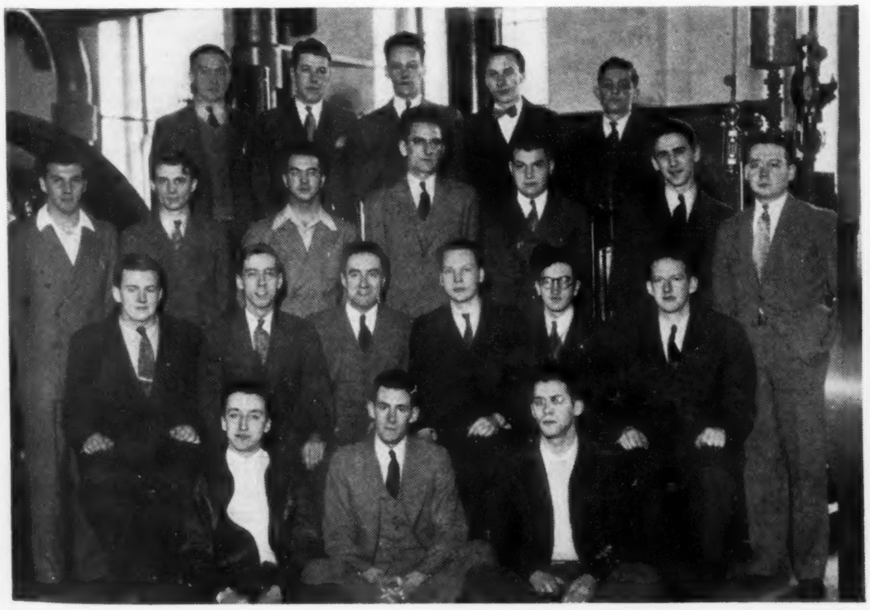
Nebraska Branch will be represented at the Student Meeting in Omaha by John Passmore and Ellis Smith.

N.Y.U. Has Three Student Branches

N.Y.U. is the only school which is represented in the A.S.M.E. by three student branches. The mechanical-engineering students at University Heights have two branches, one for the regular students and another for those taking aeronautical engineering. Then about 12 miles downtown at Washington Square, there is the third branch for evening-school students. The regular students and the evening students have Prof. Charles Gus for their honorary chairman.

N.Y.U. Branch members had their picture taken and sent a copy to Mechanical Engineering. In the photograph in the lower left-hand corner of this page there are, reading from left to right: Meade, Land, and White in the first row; Hardgrove, Mueller, Professor Gus, Swenson (chairman), Nooger, and Friedman in the second row; Mandell, Wegbreit, Davidoff, McHugh, Schuldes, Schneider, and Epstein in the third row; and McGuigan, Wolf, Stone, Behun, and Conetta in the rear row.

N.Y.U. Branch (evening) members made a trip to the Waterside Station of the Consolidated Edison Company. M. J. Berg, chairman, was unanimously elected to represent the branch at the Student Meeting in Philadelphia. His paper is on "Fuel-Injection Systems for Diesel Engines."



NEW YORK UNIVERSITY STUDENT BRANCH MEMBERS IN THE MECHANICAL-ENGINEERING LABORATORY

Father and Son Smoker at Newark

The annual "father and son" smoker was held by Newark Branch at which technical papers were delivered by F. Northrop, R. Dobbins, and J. Hopkins. After the talks, a fencing match was held and refreshments served amid the steam engines and other machinery in the mechanical-engineering laboratory. See photograph on this page.

North Dakota Branch inspected the steam plant of the Red River Power Company on an evening trip. E. E. Stone demonstrated and described the boiler, turbine, and condenser, which were installed recently.

Ohio State Branch members paid a visit to a demonstration sponsored by the Ethyl Corporation.

Oklahoma A. & M. Branch members learned all about Europe from Clarence Glasgow, recent graduate and member, A.S.M.E., who made a trip there recently.

Penn State Members Like Papers

Penn State Branch members would rather listen to papers by students than see motion pictures according to attendance figures of meetings. At one meeting, talks were given by D. Gibson on the production of roller bearings, and by C. Jedrziewski on the production of belt and sole leather. Another meeting had J. S. Chandler, a graduate student, who gave

an illustrated lecture on the classification of Diesel fuel oils.

PRATT BRANCH selected Edgar M. Hakanson for its representative to the Student Meeting in Philadelphia. His paper is on "Precision in Modern Industry."

PURDUE BRANCH member E. W. Heller was not only chosen to represent the branch at the Student Meeting but won $5 for giving the best paper at the elimination contest. "The Inside Story" was the title of the motion picture presented at another meeting by R. J. Boatman of the Socony-Vacuum Oil Company. Professors Ault and Arm, who were present, are thinking of borrowing the film to work in with their machine-design course.

TULANE BRANCH AND LOUISIANA BRANCH MEMBERS HAVE JOINT MEETING AT LOUISIANA STATE UNIVERSITY

Rensselaer Visits Eastern Plants

Under the leadership of Prof. John G. Fairfield, several members of RENSSELAER POLY BRANCH visited several places of educational interest during engineering-trip week. The first stop was the engine room of the S.S. *Deutschland* in New York Harbor. Then the members were taken through the Holland and Lincoln Tunnels where the ventilating equipment proved to be of great interest. Next to be inspected was the Brooklyn Navy Yard and the Hudson Avenue power plant of the Brooklyn Edison Company. The Westinghouse Company's Philadelphia plant, the General Motors assembly plant at Linden, N. J., and the Singer Manufacturing Company plant at Elizabeth, N. J., were others which were visited.

ROSE POLY BRANCH will be represented at Milwaukee by Jack Merrifield who won in a contest conducted by the branch. "Practical Experiences in Industry" was the subject of his paper.

SOUTHERN CALIFORNIA BRANCH members saw a $^1/_8$ horsepower gasoline engine, weighing 24 oz., assembled and run in a demonstration by J. H. Ryder. In a speed test, the engine was able to turn over at 3000 rpm when cooled by a stream of air from a vacuum cleaner.

S.M.U. Welcomes President Davis

All classwork for students in the engineering school was suspended in the afternoon of March 14 to permit them to attend a meeting of the SOUTHERN METHODIST BRANCH to hear Harvey N. Davis, president of the A.S.M.E., talk on "The Engineer of the Future."

STEVENS TECH BRANCH conducted trips to the Harrison plant of the Crucible Steel Company and to the repair shops of the D. L. and W. Railroad. Next on the series of trips was the Merck Chemical Co. plant in Rahway, N. J., which was visited on April 6.

TEXAS A. & M. COLLEGE BRANCH was represented at the Student Meeting held on its campus by R. A. Marsh, who spoke on "The Development and Maintenance of Railway Track" and by R. E. White, who gave a paper on "The Use of Alloy Steels for Cracking Still Tubes."

TORONTO BRANCH was represented at the Student Meeting by its chairman, V. M. Parrish. His paper was entitled, "Governing of Hydraulic Turbines," and dealt with fundamentals, which included the design and operation of a hydraulic-turbine governor.

Tulane Members Guests of L.S.U. Branch

Members of TULANE BRANCH visited LOUISIANA STATE BRANCH where they were royally welcomed and conducted on an inspection trip through the various engineering laboratories of the school. Following this trip, the TULANE student members were guests of the LOUISIANA STATE BRANCH at luncheon. In the afternoon, both branches went to the refining plant of the Standard Oil Company where the process of extracting the various constituents from crude oil was observed.

UTAH BRANCH was in complete charge of the mechanical-engineering exhibits and laboratories for Engineers' Week, March 28 to April 1. Henry Mattson, vice-chairman, represented the branch at the Student Meeting in Fort Collins. His paper traced the history of the oil industry from 400 B. C. to the present time.

VANDERBILT BRANCH expected to be represented in Atlanta by at least 25 members. In preparation for the Student Group Meeting, Pettey spoke on "Fuel Injection in the Spark-Ignition Engine," Van Dyke covered the subject of "Supercharging in Regard to Modern Automobiles," and Walsh outlined the "Factors in the Design of Fuel-Injection Nozzles for High-Speed Compression-Ignition Engines."

Vermont Completes Successful Year

Under the chairmanship of Fred T. Gear, VERMONT BRANCH has completed one of the best years it has ever had. Trips, meetings, socials, and smokers helped to keep interest alive in the branch, especially with each and every member on one or more of the committees arranging the various affairs. The meetings must be good when students, who were graduated years ago, come back to them.

V.P.I. BRANCH had as its guest speaker, Prof. J. I. Clower, an authority on the subject of lubrication, who talked on oil filters, describing their construction and operation with the aid of slides.

WASHINGTON BRANCH selected from among five contestants for the honor of representing the branch at the Student Group Meeting, Robert Hage, who spoke on "The Economical

STUDENT BRANCH MEMBERS AT THE UNIVERSITY OF VERMONT WITH "POCKET" SLIDE RULE

UNIVERSITY OF NEBRASKA STUDENT BRANCH MEMBERS WITH FACULTY MEMBERS OF MECHANICAL-ENGINEERING DEPARTMENT

Limitations of the Size of Flying Boats," analyzing the problem from a mathematical viewpoint. Second place went to Robert Henderson. According to latest reports, Henderson won second prize and Hage got fourth prize at the Seattle Student Meeting.

Washington State Branch members are very happy over the fact that their representative at the Seattle Student Meeting, Ivan A. Shirk, won first prize with his paper on the "Determination of Torsional Stress Concentration to Be Used in Design."

A.S.M.E. Branch Exhibit at Yale

The activities of the Yale Branch during the month of February were entirely devoted to the preparation of mechanical-engineering exhibits for the third annual Yale Engineering Exhibition. Sophomores, juniors, and seniors all worked hard and were successful if the great interest of the public in the boys' exhibits is any criterion. Gordon Harrington vied with Prof. Frederic W. Keator in an exhibition of their model trains. Other student members in demonstrating various testing machines reminded one of those men who explain the insides of cars at automobile shows; in other words, they were perfect. Approximately 1500 persons came and saw, among them Charles Seymour, president of Yale University, who was conducted through the exhibition by Samuel W. Dudley, dean of the engineering school and manager of the A.S.M.E. All members did their part, but special honorable mention should be given for extra work to W. P. Palmer, D. Irwin, P. O'Gorman, S. S. Board, Jr., W. Gray, and L. Doty.

Louisiana State University Dedicates Buildings

In CONNECTION with the formal dedication of Leche Hall for the law school, the women's dormitories, and the buildings of the agricultural center at Louisiana State University, a group of conferences on higher education in law, engineering, and agriculture, was held April 6–9, 1938.

The impact of federal governmental agencies on engineering education was discussed on April 6 by W. R. Woolrich, member, A.S.M.E., and dean of the college of engineering, University of Texas. A luncheon on Thursday, April 7, had as principal speaker, R. L. Sackett, past vice-president, A.S.M.E., and dean emeritus of the School of Engineering, Pennsylvania State College. Following the luncheon, mechanics as a fundamental of engineering education was the subject of a paper presented by Stephen Timoshenko, member, A.S.M.E., and Worcester Reed Warner Medalist. Accrediting agencies and their influence on engineering education provided the topic for the final conference on Friday, April 8.

The American Society of Mechanical Engineers was officially represented at the dedication ceremonies by James M. Todd, vice-president of the Society.

J. E. Younger to Head M.E. Department at Maryland

EFFECTIVE July 1, 1938, John E. Younger, professor of mechanical engineering at the University of California, will become professor and chairman of the department of mechanical engineering of the Unversity of Maryland, according to an announcement by Dean S. S. Steinberg.

Precollege Conference Offered by Lafayette

FOR THE fifth year, Lafayette College is conducting an Engineering Conference for high-school and preparatory-school boys from June 19 to July 2, 1938. During the two weeks of the Conference, the boys occupy one of the school's dormitories, eat at the faculty club, and follow a program which consists of engineering exercises and demonstrations in the engineering laboratories; talks by authorities of the several branches of the engineering profession, lectures, personal interviews, and aptitude determinations by national authorities on vocational guidance; visits to industrial plants, mines, and quarries; and recreation under the direction of trained athletic instructors, including hiking and picnicking in the nearby Pocono Mountains.

The lectures and the laboratory demonstrations, in which the boys participate, will include important features in the professional fields of engineering together with business administrative functions within the several divisions. The general purpose of the Conference is to provide counsel and guidance for the young men expecting to enter college, regardless of whether they may wish to study engineering or not. If more details are desired, they may be obtained by writing the Director, Lafayette Engineering Conference for Boys, Easton, Pennsylvania.

A. N. Talbot Member A.S.M.E., Honored

THE PRESENT materials-testing laboratory of the University of Illinois has been renamed the Arthur Newell Talbot Laboratory after a convocation ceremony on Apr. 21, 1938. Already the recipient of the highest awards conferred by the societies of his professional interests, Doctor Talbot, member, A.S.M.E., and past-president, A.S.C.E., was thus honored by his alma mater for those brilliantly active years as a teacher and an investigator which have contributed so much to the University of Illinois and to the engineering profession.

Under Doctor Talbot's direction the University of Illinois developed systematic laboratory work in strength of materials as early as 1890, his efforts culminating in one of the best-equipped materials-testing laboratories in the country. Under his direction, too, have been made important studies of the properties of built-up iron and steel members, brick and terra-cotta columns, timber, paving brick, and reinforced concrete.

Robert E. Doherty, president of Carnegie Institute of Technology, made the principal address at the afternoon ceremony held in the school's newly remodeled auditorium. A banquet and reception held in the evening of the same day brought the celebration to a close.

The University of Illinois is publishing a booklet entitled, "A Tribute to Arthur Newell Talbot," commemorating the renaming of the laboratory. A limited number will be available upon application to Prof. F. E. Richart, College of Engineering, Urbana, Illinois.

THE ARTHUR NEWELL TALBOT LABORATORY

Other Engineering Activities

A.S.C.E. Reports on Unionization of Engineers

THE BOARD of Direction of the American Society of Civil Engineers at its January meeting received and ordered published in *Civil Engineering* the main features of a special committee's report on the extent of the unionization movement among engineers and subprofessional men in the engineering field together with the committee's conclusions and recommendations on the professional questions involved. An abstract of the report for the information of members of the A.S.M.E., follows:

Legal Status of the Engineer

The legal status of the engineer under the Wagner Labor Relations Act according to the A.S.C.E. report, has been uncertain until quite recently. In November, 1937, the National Labor Relations Board made a ruling with respect to the engineers in the West Allis plant of the Allis-Chalmers Manufacturing Company. These engineers have their own independent union, and the board ruled that this union should be recognized as a separate bargaining agency and that even though the engineers subsequently voted to join the plant local of the U.A.W.A., it will still be considered a separate bargaining group.

Coercion of Engineers

Though there have been numerous reports that engineers have been forced to join unions against their will, no positive evidence of coercion has been found by the A.S.C.E. committee. However, the report points out, coercion is difficult to prove, and men who have been forced to join a union against their best judgment would naturally refrain from laying themselves open to further difficulty. As both union groups favor closed-shop agreements, there must be some coercion of employees who do not belong to the union if they are to hold their jobs.

Conclusions

The whole matter of unionization of engineers is in a state of flux The ultimate outcome, the committee believes, will depend in no small measure upon the attitude adopted by the men who now stand in influential positions in the engineering profession. If they will take an open-minded attitude and will do what they can to help underpaid engineering employees to improve their economic condition, it can be confidently expected that the need for collective action by engineers will be greatly diminished and the collective-bargaining agencies that will represent engineering employees in the future will have few if any of the unfavorable characteristics of trade unions as they are known today.

The fundamental principles upon which unions are built are, according to the report, sound, and are now the law of the land; those who have turned to trade unions for the solution of their economic ills hold that the bad practices can be eliminated. It is the view of the committee that it would be a serious mistake for the American Society of Civil Engineers to set up any bar against the efforts of these men to perfect any agency that they believe will improve their economic condition. Nor should the A.S.C.E. take a negative attitude in the matter. It should continue its activities directed toward improving the standards of compensation for engineering employees, and, if the occasion arises, it should stand ready to participate in moves to improve the position of the engineers under the Wagner Act.

Recommendations

To these ends the committee makes the following recommendations:

1 Membership in a trade union is primarily an economic matter. Therefore, the American Society of Civil Engineers should consider such membership as having no more bearing on a man's qualifications for membership in the Society than have his religious or political affiliations.

2 The Wagner Act has encouraged the extension of existing unions and the formation of others; it has paved the way for complete unionization of the employees of many industries and may be expected to result in the formation of collective bargaining groups in all plants and offices where any considerable numbers of men are employed. Engineers and architects as well as draftsmen and other subprofessional men are not and cannot be exempted from the provisions of the act. Therefore, the Society should not participate in any movement to amend the act to exclude professional men from its provisions. Such a movement would be bound to fail, as many engineers believe that collective bargaining can be made to work to their advantage and will fight for their rights under the Wagner Act.

3 The Society should support efforts to amend the Wagner Act to clarify the position of professional and subprofessional men under the Act should that appear necessary.

4 Extension of unionization to include a large part of the employees of some industries and its possible extension to many other organizations has made it desirable in some instances for engineers to organize to protect their own rights. In other instances engineers have organized or have joined existing trade unions in the belief that they can better their economic position thereby.

These existing trade unions are far from ideal to represent engineers in collective action. Experience has shown that such action can be taken by engineers themselves without resort to strikes and other trade-union tactics. Therefore, on the assumption that the need for facilities for collective action by engineers will increase at least temporarily in the future as the organization of industry expands, the Society should stand ready to cooperate with other Founder Societies or with state and national professional societies in the establishment of temporary or permanent agencies to represent engineers in collective action in a dignified professional manner whenever necessary.

5 To minimize the need for collective action by engineers as well as to assist its members in establishing and maintaining adequate and reasonably uniform compensation for the several grades of engineering employment, the Society should adopt a schedule of grades and minimum compensation such as is now before the Board of Direction. The Society should seek actively to have such a schedule widely accepted and should be prepared to cite a member for unethical practice who pays less than the established minimums for the region in which his business is conducted, except under emergency conditions.

Franklin Statue Dedication Ceremonies, May 19–21

President Davis to Deliver Talk on Applied Science

PLANS for the colorful and significant events which will center at The Franklin Institute in Philadelphia during the three-day formal dedication of the Franklin Memorial Statue on May 19, 20, and 21, are almost completed. The President of the United States has expressed his intention to go to Philadelphia on May 19 to unveil the James Earle Fraser statue of Benjamin Franklin in Franklin Hall, and tentative plans are being made for a great civic reception. World-wide radio broadcasting of the unveiling ceremony is contemplated.

Lectures on applied science will be given in the lecture hall on Saturday, May 21, by President Harvey N. Davis and other speakers of note in the fields of research and engineering. The Society is represented officially on the Applied Science Committee by Nevin E. Funk.

A Further Unwin Memorial Effort

FRIENDS, associates, and past students of the late Dr. W. C. Unwin, throughout the entire world, have taken steps to commemorate the valuable service Dr. Unwin rendered to engineering science through research and published writings and particularly through his leadership in the education of engineers. The Committee in London, composed of Dr. Unwin's former students and associates, with which representatives of the American Society of Civil Engineers and The American Society of Mechanical Engineers were affiliated, are engaged in raising a fund to amplify the endowment for the Unwin Scholarship awarded annually at the Central Technical College, London, and to provide a suitable memoir of Dr. Unwin's life.

Dr. Unwin was a world figure in engineering

and education. He was a leading authority in many branches of engineering, including hydraulics, pneumatics, gas distribution, steam-power engineering, bridge construction, design of masonry dams, strength and testing of materials, and machine design. In the United States he was well known for his work on the International Niagara Commission and for his textbooks which were widely used in this country.

Dr. Unwin died in 1933 having been the recipient of nearly every honor that could be conferred upon him by his fellow engineers. He served as president of the Institution of Civil Engineers and the Institution of Mechanical Engineers and was an Honorary Member of both bodies as well as of the American Society of Civil Engineers and The American Society of Mechanical Engineers. He was awarded the first Kelvin Medal, the highest honor bestowed by British engineers. The Unwin Memorial Committee will be gratified with any expression of interest by its colleagues in the United States and it will be particularly pleased to have them contribute. Contributions may be sent to E. G. Walker, Honorary Treasurer, 82 Victoria St., London S. W. 1, England.

Air Hygiene Foundation Issues Industrial Health Bulletin

A SERIES of informative bulletins on practical engineering measures for combating occupational disease is being issued by Air Hygiene Foundation, 4400 Fifth Avenue, Pittsburgh, Pa., a nonprofit organization for the advancement of industrial health. The first of the series deals with "Determination of Benzol Vapor in the Atmosphere" and the second covers the "Use and Care of Respirators."

The bulletins are being prepared by members of the Foundation's preventive engineering committee and other specialists. Prof. Philip Drinker, Harvard School of Public Health, is chairman of the committee. Other members are W. A. Cook, Chicago; J. M. DallaValle, Washington, D. C.; T. F. Hatch, member, A.S.M.E., New York; H. M. Nichols, Hyde Park, Mass.; S. C. Vessy, Cleveland; and W. P. Yant, Pittsburgh.

The bulletin on respirators points out that the most important use of "respiratory protective devices" is under working conditions where protection is required intermittently, as in cleaning-out operations, sweeping, after blasting, in removing cores from large foundry castings, shoveling, screening, and handling of materials, and the operation and maintenance of processing equipment.

The other bulletin describes the method of determining benzol vapor in the atmosphere, a subject of importance in the coking, steel, automotive, fuel, and chemical fields. It lists apparatus and reagents required and describes the procedure for taking samples and for their analysis, either by a volumetric or a colorimetric method. References are given as well as information as to where the necessary apparatus may be obtained.

M.I.T. Offers Special Course in Strength of Materials

A SPECIAL summer program and conferences on strength of materials will be held at the Massachusetts Institute of Technology for four weeks, beginning June 13, to extend the application of concrete, steel, and wood through a knowledge of their characteristics.

The different aspects of the strength problems of these materials will be critically discussed by experts on the staff of the Institute supported by certain outstanding authorities from industry and various laboratories. Representatives from the Forest Products Laboratory, Madison, Wisconsin, and the American Lumber Manufacturers Association, Washington, D. C., will take part in the lumber program. Talks on concrete will be given by specialists of the Tennessee Valley Authority and of the Thompson Lichtner Company, Boston.

One of the series of lectures will be devoted to a presentation of the known facts underlying the strength of steels and a comparison of these data with what is known regarding concrete and timber. Two all-day conferences at which representatives from industry will discuss the special features and new developments in these respective fields will conclude the program. The graduate school of the Institute will allow credit for nine units of advanced study (nine units of A subjects) for the satisfactory completion of this special course. Further particulars may be had from J. M. Lessells, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Prominent Foreign Speakers at Applied Mechanics Congress

THE FIFTH International Congress for Applied Mechanics which meets at Harvard and M.I.T., Sept. 12–16, 1938, will be distinguished by a general lecture on the strength properties of steel by Dr. F. Koerber, director of the Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf, Germany. A lecture on turbulence is scheduled to be given by G. I. Taylor, professor of the Royal Society, in which he will develop a new statistical theory of this baffling phenomenon. From France, Prof. J. Peres of the laboratory of fluid mechanics of the University of Paris, will discuss methods of analogy in applied mechanics.

I.E.C. Plenary Meeting to Be Held in England

THE COMMITTEE of Action of the International Electrotechnical Commission has accepted the British National Committee's invitation to hold the next plenary meeting in England, June 22–30, 1938. Arrangements have been completed to hold the sessions in Torquay, which is located on the south coast of Devonshire. Additional information may be obtained from the Central Office of the I.E.C., 28 Victoria Street, London, S. W. 1.

Foundrymen to Meet at Cleveland, May 16–19

MORE THAN forty technical sessions, luncheons, and dinners are scheduled during the 42nd annual convention of the American Foundrymen's Association which will be held in Cleveland, May 16–19. Items to be discussed include gray iron, nonferrous founding, foreman training, patternmaking, refractories, job evaluation, steel, apprentice training, cost methods, malleable cast iron, sand research, materials handling, foundry safety and hygiene. Further information may be obtained from the secretary, Dan M. Avey, American Foundrymen's Association, 222 W. Adams Street, Chicago, Illinois.

Lehigh Inaugurates Annual Anthracite Conference

SURVEYING recent engineering developments in the mining and utilization of anthracite, an Anthracite Conference, which is expected to become an annual affair, has been scheduled by Lehigh University for April 29 and 30. The conference committee, Herman Eckfeldt, chairman, and including the following A.S.M.E. members, Allen J. Johnson, Fred V. Larkin, and W. H. Lesser, has arranged for presentation of 18 technical papers. These are intended to focus interest on the rapid engineering progress being made in production, distribution, automatic burning and consumer economy of anthracite. Additional reports of the utilization of ash, and the nonfuel uses of anthracite will also be included in the two-day discussion.

Among the papers to be presented are the following by A.S.M.E. members: "Some Practical Considerations in Connection With Combustion," by Allen J. Johnson; "Air Conditioning and Refrigeration," by B. H. Jennings; "The Pulverization of Anthracite for Commercial Use," by Martin Frisch; and "The Relation of the Type of Fuel to the Cleanliness of Communities," by W. G. Christy.

Engineers Make Survey of New England Industries

THE EXTENT of modernization activities in New England manufacturing plants and the opportunities which exist for the further improvement of plant facilities and equipment are the keynotes of a survey which the New England Council and the Engineering Societies of New England, Inc., of which the Boston Section, A.S.M.E., is an affiliated body, are conducting among 2500 New England manufacturers. The survey, in the form of a series of self-analysis questions, will disclose the

present status of New England manufacturing machinery and provide the basis for a long-range program of plant modernization.

Embracing various phases of material, maintenance, machinery, and production costs, the inquiry further points out methods which manufacturers have used to maintain and improve their competitive position. It also asks for recent examples of modernization activities which have increased income and decreased costs. The results of the survey in a summary form will be made public as soon as returns are tabulated.

Coordinator for Co-Op Plan Appointed at Carnegie Tech

PART OF the plan announced last fall when the Westinghouse Electric and Manufacturing Company appropriated $200,000 to the endowment of Carnegie Institute of Technology, was the creation of the chair of George Westinghouse Professor of Engineering. Douglas F. Miner has been appointed to fill the position, according to an announcement made by Robert E. Doherty, president of Tech.

Professor Miner, who will assume his new duties on September 1, has been manager of the central engineering laboratories of the Westinghouse company. He will act as co-ordinator for the Westinghouse cooperative plan under which a qualified group of engineering students at Carnegie Tech will take the usual technical college courses, and during the same period will receive shop and engineering experience at the Westinghouse plant. Under this plan ten scholarships will be awarded annually to exceptional students, each of whom will receive the sum of $3000 over the five-year period required by the course. Students may follow any of the engineering courses given at Tech.

New Hydraulics Laboratories List Now Available

A REPORT entitled, "New Hydraulic Laboratories and Their Work" has just been prepared by Dr. R. Ruedy of the Division of Research Information, National Research Council, Ottowa, Canada. Containing 18 plates, the mimeographed report is available for distribution to libraries and others interested in the study of new developments in this field of work. Price per copy is $1. It brings up-to-date the list in the English edition of "Hydraulic Laboratory Practice," edited by John R. Freeman, past-president of the A.S.M.E., and published by the A.S.M.E. in 1929, containing information of European and American laboratories which were built prior to 1929.

Edison Tower Photograph

IN ANSWER to the requests of several readers for information, the photograph of the Edison Memorial Tower which appeared in our April, 1938, issue, was supplied by Walter Kidde Constructors, Inc., builders of the tower.

E. S. Burdell to Be Director of Cooper Union

EDWIN SHARP BURDELL, dean of humanities at the Massachusetts Institute of Technology, has been appointed director of Cooper Union in New York City, a new executive post created by the trustees of the Union. He will assume his duties at the beginning of the seventy-ninth academic year on July 1, 1938.

Trustees of Cooper Union are Gano Dunn, member, A.S.M.E., J. P. Morgan, Elihu Root, Jr., Walter S. Gifford, and Barklie Henry. The treasurer is Percy R. Pyne, Jr. Mr. Dunn has been president since 1935, when he succeeded R. Fulton Cutting. Since it was organized in 1859 by Peter Cooper, the Union has provided free education for more than 200,000 men and women.

Tool Engineers Install New Officers

DURING the first annual convention of the American Society of Tool Engineers held in Detroit, March 9–12, 1938, the formal banquet on Friday night, with some 500 members and guests attending, was featured by the installation of the newly elected officers of the Society. These officers are: W. F. Wagner, president; James R. Weaver, member, A.S.M.E. first vice-president; G. Smart, second vice-president; and C. F. Staples, secretary. F. R. Crone was reelected as treasurer and Ford R. Lamb as executive secretary.

The address of the evening was delivered by Ralph E. Flanders, past-president, A.S.M.E., who urged greater cooperation of industry and government. The idea of holding the Machine and Tool Progress Exhibition, run in conjunction with the meeting, was thought up by Mr. Weaver, who experienced the pleasure of having the exhibition turn out to be one of the most successful held in Detroit this year.

M. E. Thornburg Represents A.S.M.E. at Inauguration

REPRESENTING the A.S.M.E. as Honorary Vice-President at the inauguration of Alfred Atkinson as president of the University of Arizona on April 12, was M. L. Thornburg, professor of mechanical engineering at the university.

Battelle Research-Associate Applications Available

FOR THE third consecutive year, four appointments as research associates are being made available at Battelle Memorial Institute, Columbus, Ohio. These appointments are open to graduates of any accredited college or university. Preference will be given to men who have demonstrated marked aptitude for scientific research in their industrial experience or by graduate study in chemistry, physics, metallurgy, or ceramics.

Appointments as research associates will be for one year's duration, including vacation, and may be extended for a second year. The salary will be $1800 a year. Application forms and further information may be secured by writing to Clyde E. Williams, director of the institute.

Conference on Aircraft Engineering Postponed

BECAUSE of a vast construction program undertaken by the National Advisory Committee for Aeronautics, the executive committee has reluctantly decided that it is necessary to postpone for one year the Aircraft Engineering Research Conference usually held in May at the N.A.C.A. laboratories at Langley Field, Virginia. The new construction program, approved by Congress, includes four new wind tunnels, additional shop facilities, and improvement of existing research equipment, and was undertaken to overcome the advantages enjoyed by aircraft research laboratories in foreign countries.

S.P.E.E. Meets in Texas June 27–30, 1938

MEMBERS of the Society for the Promotion of Engineering Education will be guests of the Agricultural and Mechanical College of Texas and of the Texas Section of the S.P.E.E. at College Station, Texas, June 27–30, 1938. To tempt tired educators to attend the session, the meeting invitation, besides showing views of buildings of various colleges in Texas, contains photographs of the fish to be caught in the Gulf of Mexico together with an air view of the bathing beach at Galveston.

Wisconsin Engineers Present Honorary Memberships

AT THE annual convention of the Engineering Society of Wisconsin, March 17 to 19, F. E. Turneaure, dean emeritus of the college of engineering of the University of Wisconsin, and D. W. Mead, member, A.S.M.E., and professor emeritus of hydraulic and sanitary engineering, were presented with honorary memberships in the society. Among the speakers at a banquet held on the evening of March 17 was C. R. Martin, member, A.S.M.E.

Business Stability Discussed at Management Conference

PLANNING for business stability was the keynote of the Industrial Management Society's annual midwestern conference in Chicago, March 25 and 26. Speakers discussed employer-employee relations, unemployment conference, occupational rating, education for industry, and other subjects of interest.

American Engineering Council

Presents
The News From Washington and Elsewhere

Secretary Feiker Reports on Work of American Engineering Council

THE AMERICAN Engineering Council, more popularly known as the Washington embassy for American engineers and engineering, is a joint organization of 51 member bodies—27 local, 17 state, and 7 national of which The American Society of Mechanical Engineers is one. The work of the Council in serving 72,000 engineers, members of the supporting organizations, is carried on by a large organization of committees and by the staff located at 744 Jackson Place, Washington, D. C. An outline of the work done last year is contained in the report given by Frederick M. Feiker, executive secretary, at the annual meeting of the Council in January. Some of the items in the report, because of their timely interest, are included in the following news briefs.

Work of Council

American Engineering Council is a nonpartisan, fact-finding agency for the expression of engineering opinion on those public questions in which engineers may have a viewpoint in the public interest as citizens, as well as professional men. From those public officials who have sought and secured factual information during the past four years, comes appreciation. During the last six months of 1937, there has been an increase in the number of requests from congressional committees and individual congressmen seeking advice from American Engineering Council on legislative proposals, and an increase in the number of requests to furnish information of factual character in public affairs, for which the Council was organized.

Frequently, contacts are made in confidence and results depend, in part at least, upon keeping these confidences. Many of those who use the engineering knowledge and experience made available to them by the engineering profession through the staff of Council would not continue to do so unless they felt free to discuss their problems "off the record" and were certain that no publicity would be connected with their inquiries.

Government Contacts

Council keeps the doors open to opportunities for public service and maintains entree to the "powers that be" for engineers and engineering organizations wishing to contact responsible government officials and to present resolutions, expressions of opinion and factual information in behalf of the engineering profession and in the public welfare. It serves as a clearing house for questions of a public nature which require technological knowledge and engineering experience, and acts as an advisory body, in connection with problems of government, for the A.S.M.E. and other engineering member societies. It is also an agency of inquiry into economic and social problems as they may be affected by technology, and more particularly by engineering.

Contacts are maintained with scores of individuals in over seventy government agencies, with members and committees of the House and Senate, and with many other organizations interested in public affairs or likely to be concerned with problems on which engineering opinion might be helpful and effective.

Government Reorganization

Council has made its files available to the President's Committee on Administrative Management and the Special Committee Investigating Executive Agencies of the Government, and stated the engineers' point of view to the Senate Select Committee on Government Organization, the several House Committees on Government Organization, and the Joint Committee on Government Organization. The members of the staff on request have advised with the many committees in presenting a wider understanding of engineers' interest in the development of a centralized agency for public works, the expansion and protection of the civil service, questions relative to national planning, and many personnel problems of organization of newly formed government agencies.

Civil Service

Within the past few years, the staff of the American Engineering Council has worked very closely with the U. S. Civil Service Commission. It seems as though Council is being consulted on almost all actions affecting engineering groups of government employees under the civil service. At the request of the commission, R. L. Sackett, past vice-president, A.S.M.E., came to Washington to aid the commission in advising as to the manner of conducting engineering civil-service examinations.

Employment of Engineers

At the request of government agencies during 1937, Council has had the opportunity to recommend in cooperation with the Engineering Societies Employment Service in New York and the secretaries of member societies a list of names of individuals qualified for government positions. American Engineering Council is not an employment agency and handles these requests as a service to the government agencies and to the profession.

Architects Ask Cooperation of Engineers

Each chapter of the American Institute of Architects is being asked to invite all individual architects and engineers to cooperate with the Federal Housing Administration in a nation-wide campaign to revive the business of building residences. It is intended to have a series of regional or district meetings in the next few weeks to discuss plans. Possibilities will be illustrated with movies and following informative addresses, each of the meetings will be turned into an open forum for discussion. Engineers and engineering organizations desiring to relate themselves to this movement, either for business reasons or in the public welfare, should contact the nearest chapter of the A.I.A. for meeting dates, programs, etc. Valuable information for construction engineers may be obtained from the local office of the F.H.A. or directly from Washington, D. C.

Train-Length Legislation

On behalf of the American Institute of Consulting Engineers, the American Engineering Council has written Chairman Clarence F. Lea of the Interstate and Foreign Commerce Committee of the House of Representatives as follows. "The council of the A.I.C.E. desires to place itself on record in opposition to the train-length bill which will not only place an unnecessary financial burden upon the railroads, but also will take away from the management of the railroads that control of its operations which is so essential to properly serve the public."

Engineer in Public Service

General Edward M. Markham, former Chief of Engineers of the U. S. Army, has been appointed Commissioner of Public Works of New York City. It is a fitting recognition for a distinguished engineer, but the very act, on the part of the officials of New York City symbolizes a trend that should become increasingly evident and a movement in city management that will be hailed by all who are concerning themselves about more efficient public administration.

WPA Seeks Criticism

The American Engineering Council has been asked to cooperate with other organizations in assisting the Works Progress Administration in an appraisal being undertaken to determine the value to the public of thousands of projects executed under CWA, FERA, WPA, and other emergency relief programs. The cooperating organizations are asked to name a "National Appraisal Committee" of

nine or more unbiased and well-known citizens to summarize, interpret and make recommendations on the future use of several thousand community reports on "relief work" in 42 states. Council has suggested the names of nationally known members of the engineering profession for this committee.

Kentucky Registration Law

Kentucky became the thirty-ninth state to adopt a registration law for professional engineers when the governor signed a bill on Mar. 11, 1938. The new law will become effective June 9, 1938.

No Patent Legislation

In the absence of a positive threat to pass legislation interfering with the rights of inventors to control and dispose of their discoveries, Council is not appearing before the subcommittee of the Patents Committee of the House of Representatives regarding pending legislation. It is believed to be more effective for the staff of Council to supply sponsors of such patent legislation with factual information indicating the true nature of present conditions, on the premise that such knowledge will serve to protect the public against any act restricting freedom of owners of patents to use them constructively under the present law.

A VISIT IS PLANNED TO THE HOME OF BUDWEISER DURING THE A.S.M.E. SEMI-ANNUAL MEETING IN JUNE

(Some of the ventilated elevators at the Budweiser plant. Barley is allowed to rest or season here before being malted, because important enzymatic changes take place during the seasoning period.)

Council Program for 1938

William McClellan, president of the American Engineering Council, announced that the work of Council for 1938, as approved by the executive committee, will be carried out under five major headings: Public Affairs' Function, Engineers' Embassy Function, Public Discussion Function, Publicity Function, and Fact Finding Function.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE

Seeks Diesel Connection, Diesel studies, responsible positions, automotive and locomotive experience; should qualify as service engineer to start. Georgia Tech graduate. Age 32. Member A.S.M.E. Prefers South or West. Me-50.

Graduate Mechanical Engineer, 27; now employed; 5 years' experience including drafting, machine design, floor layouts, planning, technical correspondence, inventories; interested in production engineering, time study, or research. Excellent educational record. Me-53.

Mechanical Engineer. Mem. A.S.M.E., 38; master's degree; 15 years' experience in heating, ventilating, air-conditioning, design, testing and installation, also power-plant design and operation. Desires connection in any of these fields. Me-54.

Draftsman-Designer. M.E. graduate; 36 years' experience design and detail of Diesel and high-speed steam engines, steam generators, printing presses, bookbinding machinery. Familiar with plumbing and heating. Desires position in Greater New York. Me-55.

Mechanical Engineering Student, 25, single; graduate Brooklyn College, mathematics and physics major. Attending Cooper Union M.E. course. Willing to start from bottom. Weather Bureau experience. Me-56.

Executive Engineer. M.I.T. graduate in business administration, 28, married; past 12 years in positions of general manager rank in small, then large, manufacturing plant and semi-public association. Me-57.

Graduate Mechanical Engineer; 13 years practical engineer, inventor and designer of special machinery; 8 years' centrifugal pump experience. Desires permanent position in engineering department. Location desired, East. Me-58.

Purchasing Agent. Graduate mechanical engineer; experienced buyer, familiar with heavy construction materials, equipment, repair parts, building and mill supplies, commissary items, chemical and industrial-plant machinery and equipment. Me-59.

Industrial Engineer. College-trained, factory experience in production control, time and motion study, and plant layout. Has been assistant to Wage Incentive and Industrial Relations authority. Available at present for interview. No geographical preference. Me-60.

Mechanical Engineer, 25; 2 years with heating trade publications. Acquainted with marketing and technical problems in domestic oil heating, stokers, and air conditioning. Stevens graduate. Junior A.S.M.E., A.S.H.V.E. Me-61.

Mechanical Engineer. Annapolis graduate, '33; desires sales position in East, representing machinery or mechanical-specialties manufacturer. Me-62.

Mechanical - Electrical Engineer. Graduate Drexel Institute; American, 40, married; 18 years' experience, power plant, chemical plant, rubber works, electrical, design, construction, and maintenance. Plant engineer for 10 years. Me-63.

Graduate Mechanical Engineer, 25, single. Experienced in steel mill and in drafting on heavy machinery. Desires work in production control or maintenance line. Me-64.

Executive Engineer seeks connection developing new mechanical products. Many years' responsible experience design and manufacture, particularly internal-combustion engines, compressors, related machinery. Capable in other lines as well. Cornell graduate. Me-65.

Young Graduate Engineer, 25, single, M.E. One year of production and one year of sales experience; desires position leading to engineering sales. Junior Mem. A.S.M.E. Me-66.

POSITIONS AVAILABLE

Sales Engineer. Graduate mechanical engineer, 30–50. Experienced with use of physical testing machines, testing standards, etc. Salary, $3000–$4000 a year. Apply by letter. Location, East or West. Y-2802.

Instructor in mechanical engineering. Will be required to teach machine design, elements of mechanical engineering, one course in elementary mathematics, and a course in mechanical drawing. In addition, will be expected to give some technical assistance in

(*Continued on page 456*)

operation of power plant of college, a combined Diesel and steam-engine installation of 600 kwhr. Teaching experience not necessary, but must have personality well adapted for effective teaching. Experience in engineering, particularly power-plant operation, desirable. Apply by letter giving full information concerning qualifications and interests, including statement of vital statistics, recent salaries, several references, and recent photograph. Salary, $1500-$2200 a year. Apply by letter. Location, Middle West. Interviews in New York, N. Y. Y-2805.

ASSISTANT PROFESSOR of industrial engineering for active supervision of and responsibility for work in time and motion study. First-class laboratory available and engineering shops for construction of equipment and time-study and motion-economy problems. Instruction will cover both stop-watch technique and use of motion-picture camera for analytical purposes. Will also be required to direct senior courses in planning and layout of industrial plants and of equipment. Must have degree in engineering, supplemented by several years of experience, preferably in industry. Experience should have included active work in first-class time-study and motion-economy program. Important that industrial experience permitted first-hand contact with management procedure to furnish a background for developing management instruction. Salary, $3000 for ten-month school year. Apply by letter. Location, Middle West. Y-2819C.

ASSISTANT PROFESSOR of engineering shop practice. Will be in charge of machine shop employing five instructors and giving instruction to approximately one thousand engineering students a year. Will also assist professor in charge of all engineering shops to develop and operate shop-instruction program of lectures and demonstrations. This program is based upon emphasis of manufacturing equipment and processes, costs of production, time and motion study, safety and production control. Must have engineering degree and responsible industrial experience in maintenance, machine-tool demonstration, or should have held supervisory position in well-organized factory. Salary, $3000 for ten-month year. Apply by letter. Location, Middle West. Y-2820C.

MECHANICAL ENGINEER, 35-50, to act as consultant and supervisor of a number of Diesel power plants. Must have at least ten years' experience, and thorough knowledge of Diesel engines and Diesel power-plant operation. Salary, $5000-$6000 a year. Considerable traveling. Apply by letter. Headquarters, New York, N. Y. Y-2825.

INSTRUCTOR in machine-shop practice. Salary, $1800-$2100 a year. Apply by letter. Location, Middle West. Y-2832C.

MASTER MECHANIC for mining position. Must be capable of taking charge of up-to-date machine shop and power plant. With six 600-hp and four 135-hp Diesel engines converted to use wood gas. In generating department are 10 gas producers burning local cordwood. Foundry will be constructed in near future. Must also be capable of maintaining usual pumps, piping, and other equipment used in mining work. Resident of West preferred. Apply by letter. Location, Venezuela, S. A. Y-2833CS.

DESIGNERS, 30-55, with five or more years' experience in design of automatic can machinery. This experience essential. Apply by letter. Location, New York, N. Y. Y-2838.

SALES MANAGER with engineering background. Must be thoroughly familiar with water treatment, filtration, sedimentation, etc. Apply by letter giving experience, salary, and references. Location, Middle West. Y-2842C.

ASSISTANT GENERAL MANAGER with experience in mechanical processing. Should also have factory experience, and be familiar with metal work. Electrical experience desirable. Salary, $4000-$5000 a year. Apply by letter. Location, Middle West. Y-2847C.

EXECUTIVE, about 45, to take charge of engineering department of mining company. Must have experience in both smelter and mine work. Operations consist of flotation mill and smelter, lead-zinc mines, coal mines, etc. Qualified to supervise current engineering matters at these properties, and must have necessary initiative to make studies such as handling of materials, etc., to improve operations and reduce costs. Salary, $500-$600 a month. Apply by letter. Location, West. Y-2855-R-7221S.

GENERAL PURCHASING AGENT, 30-35, married, for State university. Apply by letter. Location, Middlewest. Y-2866C.

COMBUSTION ENGINEER for servicing and sales work. Must have bituminous-coal experience. Apply by letter. Location, East. Y-2875.

INSTRUCTOR, graduate mechanical engineer, to teach courses in metalworking and other shop processes. Will also assist in courses in process machinery, design of machine parts, and mechanical-engineering laboratory. Shop courses are presented as lecture and classroom courses, supplemented by machine demonstrations and student experiments of an engineering-laboratory nature. Process-machinery course requires some knowledge of types of machines used in wide variety of industries. Practical experience in industry essential. Duties will start July 1, 1938. Salary, $2400 a year. Apply by letter. Location, East. Y-2879.

GRADUATE MECHANICAL OR CHEMICAL ENGINEER, age 27-35, sales and service work with reputable consultants on water conditioning. Applicants must have sound theoretical knowledge and practical experience in this field, and must present proved sales record. Consideration given only to engineers in the vicinity of Cincinnati, Ohio. Salary, $1500-$1800 to start. R-603C. Y-2894.

Local Sections

Coming Meetings

Anthracite-Lehigh Valley: May 27. Americus Hotel, Allentown, Pa., at 8:00 p.m. Subject: "Apprenticeship Training," by C. R. Dooley, industrial-relations manager, Socony Vacuum Oil Co., New York City, and W. F. Patterson, executive secretary of the Federal Committee on Apprenticeship Training.

Baltimore: May 13. Probable meeting place: Maryland Academy of Sciences. Subject: "Stratosphere Flights," by Dr. Lyman J. Briggs. Ladies are cordially invited to attend this meeting. Refreshments will be served.

Central Pennsylvania: May 4. Penn Alto Hotel, Altoona, Pa., at 7:00 p.m. This will be a joint dinner meeting with the Altoona Engineering Society and the Centre County Engineers Society. Subjects: "Railroading With Modern Power," by W. M. Guynes, manager, locomotive and electrification section, General Electric Company; and "Dynamical Measurements of Movements and Stresses in Railroad Tracks," by F. M. Graham assistant engineer of standards, Pennsylvania Railroad Company.

Chicago: May 3. Junior Group Meeting. Subject: "Training Aviators," by John W. Hurley, flight instructor, Naval Aviation Cadets, Great Lakes Naval Training Station.

May 10. Management Division of Section. Subject: "Industrial Marketing and Advertising," by M. J. Evans, Evans & Associates, Inc., Chicago, Ill.

May 17. Power and Fuels Division of Section. Subject: "Gas and Fuel for Industrial and Power Purposes," by G. W. Akerlow, industrial engineer, Western United Gas & Electric Co., Aurora, Ill.

May 24. Manufacturing Division of Section. Subject: "Hydraulic Transmission of Power," by Walter Ferris, vice-president, Oilgear Company.

May 31. Management Division of Section. Subject: "Pricing, Costs and Profits Which Will Take Up the Basis for Pricing, Relationship of Costs, Determination of Profit," by C. S. Carney, consulting engineer, Stevenson, Jordan & Harrison.

All the Chicago meetings scheduled will be held in the Civic Opera Building, 20 North Wacker Drive, Chicago, Ill. The Management meetings on May 10 and 31 will be held on floor 38.

Detroit: May 4. University Club, Detroit, Mich., at 6:00 p.m. Joint meeting with the Student Branches at University of Michigan,

(*Continued on page 458*)

Michigan State College, and the University of Detroit. Dr. Harvey N. Davis, president of The American Society of Mechanical Engineers, will talk on "The Engineer of the Future."

Erie: May 17. Knox Hall at 6:30 p.m. This will be the annual joint dinner meeting and Ladies Night with the American Institute of Electrical Engineers. Subject: "Grand Coulee Dam," by John C. Page, Member of the Federal Reclamation Commission.

Greenville: Early in May. Clemson College, S. C., at 10:00 a.m. This will be a joint meeting with Master Mechanics Division of Southern Textile Association. A.S.M.E. will present a paper on "Air Conditioning of Textile Mills" and Master Mechanics Division will give one on some engineering development in Textile Mills.

New Haven: May 11. An all-day meeting of the Local Sections of Connecticut, to be held under the auspices of the New Haven Section. Golf at the New Haven Country Club in the morning, plant visits and techical sessions in the afternoon, with dinner at the New Haven Lawn Club. Technical sessions will be held at Strathcona Hall at Yale with addresses by Willis H. Carrier well-known in the air-conditioning field and Merton A. Robinson, balastic expert of the Winchester Repeating Arms Co. In the evening Dr. Howard W. Haggard of medical and radio fame will address the meeting.

Ontario: May 20. The Plant of the Babcock-Wilcox & Goldie-McCulloch, Ltd., at Galt, Ont., Can., at 8:00 p.m. Members of the Buffalo Section are cordially invited to attend this meeting. Subject: "Modern Developments in Boiler Practice," by Alfred Iddles, assistant to the vice-president in charge of engineering, Babcock-Wilcox Company, New York, N. Y.

San Francisco: May 26. Excursions to "Treasure Island" and dinner meeting to learn about progress and plans of the Golden Gate International Exposition.

Waterbury: May 18. The Elton Hotel, Waterbury, Conn., at 8:00 p.m. Subject: "Ladies Night—Industrial Kitchendom," by L. V. Burton, Editor of *Food Industries*.

Worcester: May 10. Sanford Riley Hall, Worcester Poly Institute—Dinner at 6:45 p.m. Meeting at 7:45 p.m. Subject: Training of Foremen, Apprentices, and Operators," by J. E. Doyle, Supervisor of Personnel, West Lynn Works of General Electric Company.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after May 25, 1938, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Rt = Reinstatement Re = Reelection
Rt & T = Reinstatement and Transfer to Member

In addition to the names given are a group of approximately 2100 transfers from Student-member to Junior Member, whose names will appear on a May Ballot to Council.

NEW APPLICATIONS

For Member, Associate, or Junior

Allen, Donald P., Springfield, Mass.
Bechtel, Luther D., Haddonfield, N. J.
Bodan, Casimir, Flushing, L. I., N. Y.
Boshoff, Wm. H., Fort Bragg, N. C.
Burk, W. A., Jr., Los Angeles, Calif.
Chadwick, Jos. J., Akron, Ohio (Rt & T)
Crawford, G. W., Muncy, Pa.
de Forest, A. V., Cambridge, Mass.
Dill, R. S., Silver Springs, Md. (Rt & T)
Duggan, Phil P., San Francisco, Calif.
Dunnington, Wm., Charleston, W. Va.
Dusinberre, Geo. Merrick, Annapolis, Md. (Rt & T)
Egli, Adolf, Philadelphia, Pa.
Erb, Harold E., Laurelton, L. I., N. Y. (Rt)
Erickson, E. B., Philadelphia, Pa.
Frocht, Max Mark, Pittsburgh, Pa.
Golden, Gene E., Washington, D. C.
Howse, Godfrey L., Chicago, Ill.
James, Clarkson W., Montreal, Quebec, Canada
Japp, Albert L., Maywood, N. J. (Rt)
Jones, Geo. M., Salt Lake City, Utah (Rt & T)
Klopsch, Otto Z., Detroit, Mich. (Rt)
Kramer, Edward L., Buffalo, N. Y.
Kreisinger, Robert H., Reading, Pa.
Lang, Leonard F., Chicago, Ill. (Rt)
Leerburger, Franklin J., New York, N. Y.
Locke, David H., Philadelphia, Pa.
Mains, Wm. D., Louisville, Ky.
McGinnis, C. Edwin, Los Angeles, Calif.
Mindlin, Raymond D., New York, N. Y.
Modrovsky, Jos., New York, N. Y.
Moore, Robert E., New York, N. Y. (Rt)
O'Rourke, Hugh D., Rochester, N. Y.
Paul, Ellis E., New York, N. Y.
Pike, Otto S., Melrose, Mass.
Pofahl, Chas. A., Jr., Milwaukee, Wis.
Pringle, John Aldon, Coytesville, N. J.
Pritchard, Fredk. Arthur, Wethersfield, Conn.
Rumpp, Emile T., Jr., Detroit, Mich.
Saginor, S. V., Charleston, W. Va.
Schmidt, Harry, Buffalo, N. Y.
Schweikart, Herbert C., Reading, Pa.
Selkirk, Richard, New York, N. Y.
Spencer, Ervin R., Tulsa, Okla.
Turner, Benton, San Francisco, Calif.
Van Norden, Ernest M., New York, N. Y.
White, Harrison G., Springfield, Mass.
Younger, John E., College Park, Md.

APPLICATIONS FOR CHANGE OF GRADING

Transfer to Fellow

Lucke, Dr. Chas. E., New York, N. Y.

Transfers to Member

Jenkins, Schuyler V., Niagara Falls, N. Y.
Ross, Jos. M., New York, N. Y.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

Alrich, Herbert W., March 25, 1938
Barker, Tom, March 14, 1938
Becker, Bernard C., March 19, 1938
Burgey, Samuel S., March 21, 1938
Heichert, H. S., December 31, 1937
Rogers, Paul K., January 11, 1938
Shirley, Robert, March 4, 1938
Stiefel, Ralph C., March 16, 1938
Unger, John S., February 25, 1938

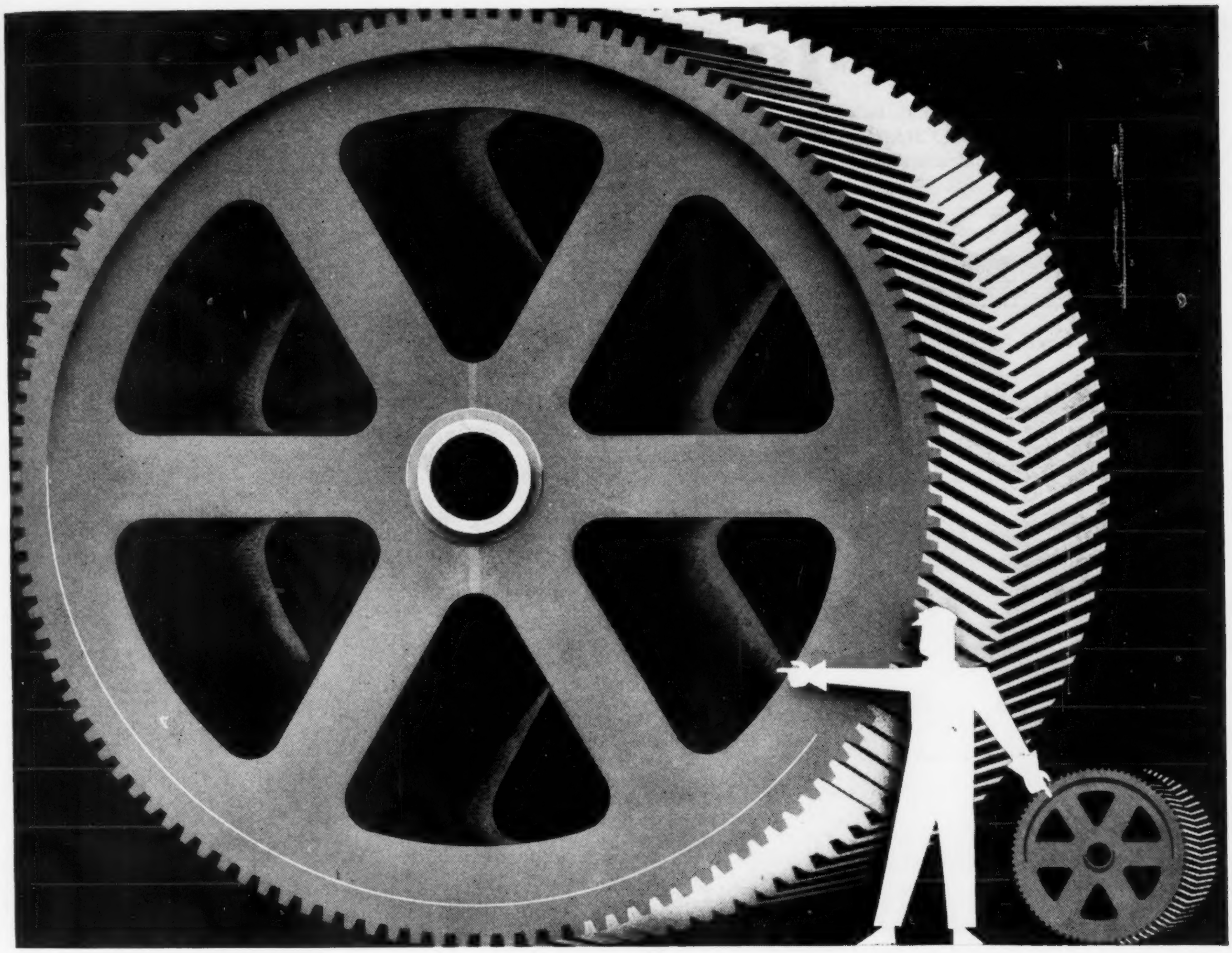
A.S.M.E. Transactions for April, 1938

THE April, 1938, issue of the Transactions of the A.S.M.E., contains the following papers:

Slag and Deslagging of Steam-Generating Equipment (FSP-60-7), by A. D. Bailey
Income Versus Production (MAN-60-1), by Walter Rautenstrauch
Some Data on Diesel-Electric Switching Locomotives (OGP-60-5), by J. W. Anderson
The Friction of Reciprocating Engines (OGP-60-6), by F. H. Dutcher
Sulphate-Resisting Cement (PME-60-1), by Svend Rordam
Some Results From Research on Flow Nozzles (RP-60-3), by H. S. Bean and S. R. Beitler
Thrust Bearings (RP-60-4), by F. C. Linn and R. Sheppard
Effect of Temperature Variation on the Creep Strength of Steels (RP-60-5), by E. L. Robinson
Decomposition of Sodium-Sulphite Solutions at Elevated Temperatures (RP-60-6), by W. O. Taff, H. E. Johnstone, and F. G. Straub

DISCUSSION

On previously published papers by Messrs. E. O. Waters, D. B. Wesstrom, D. B. Rossheim, and F. S. G. Williams; H. S. Hersey; A. C. Stern; and I. I. Sylvester



DIFFERENT IN SIZE . . . ALIKE IN STEEL

It's a big jump from a 36-inch gear to one of 16 feet weighing 53,000 pounds. Yet their case histories show that such widely varying sizes can be handled with one steel. In these instances a Manganese-Molybdenum (0.15 to 0.20% Mo) steel was used.

In the large gear simple annealing, normalizing and drawing proved sufficient to produce uniformly good physical properties. The smaller gear permitted oil quenching and drawing to even higher physical properties. And, despite the wide variations in sections, no casting defects or machining difficulties were encountered in either of the two products.

Such is the versatility of Moly cast steels. Our free book, ***"Molybdenum in Steel,"*** tells more about them; and our accumulation of practical field data is available to engineers and production executives toward the solution of any specific iron or steel problem. Climax Molybdenum Co., 500 Fifth Ave., N. Y.

PRODUCERS OF FERRO-MOLYBDENUM, CALCIUM MOLYBDATE AND MOLYBDENUM TRIOXIDE

MOLY

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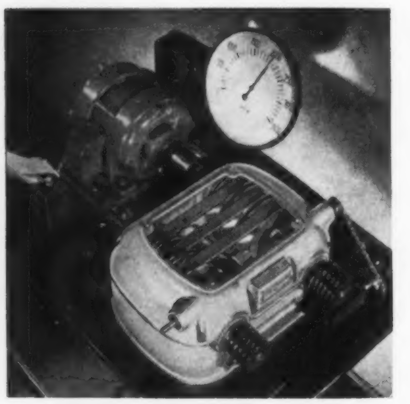
• NEW EQUIPMENT
• BUSINESS CHANGES
• LATEST CATALOGS

Announcements from advertisers in MECHANICAL ENGINEERING and the MECHANICAL CATALOG

• NEW EQUIPMENT

New Vari-Pitch Speed Changer

The Texrope Division, Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has just put on the market a new Speed Changer Unit said to open up new horizons in variable speed transmission. It utilizes the already well known principle of that Company's multi-groove Vari-Pitch Sheaves.



The new Speed Changer consists of a ruggedly constructed very compact type of unit applicable to all manner of industry. This totally enclosed unit, designed with double shaft extensions and driven from a standard motor, provides the flexibility that makes it adaptable to a wide variety of layouts to suit the individual application. Where the change in speed is to be adjusted manually only, the unit is provided with a readily accessible hand wheel control. However, the unit can be equipped for electric remote control. Manual remote control is also possible. The present range of capacities now being offered includes ratings up to 33 horse power with ratios as high as 3-3/4 to 1. It is expected that larger ratings will be developed in the future.

The new Allis-Chalmers Speed Changer Unit has been designed to fill the need for equipment in any industry where a substantial change in speed is desirable to better control production. It is especially applicable where material handling equipment must be controlled. Exhibition units are being shown at the principal national trade expositions. Descriptive bulletin 1266 may be obtained from their nearest district office.

Series Sixty Blueprint Papers

Blueprint papers of a radically new type have been announced by Keuffel & Esser Co., Hoboken, N. J. The improved papers are named "Series Sixty," and they are said to produce prints of an unusually deep blue color, so that the white lines of the reproductions stand out in sharp, legible contrast. This extra color strength gives blueprints a high contrast ratio, and it makes them as legible as original drawings.

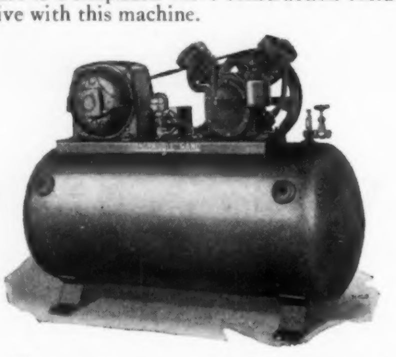
An exceptionally wide printing range is also claimed for Series Sixty Blueprint Papers. Tracings of varying transparency can be printed successfully at a single setting of the machine—or strong blueprints can be made from any tracing within a broad range of machine speeds. This extra margin of printing range reduces the danger of over exposure and under exposure, eliminates the necessity for "trial prints" and greatly speeds production.

Unlike ordinary blueprint papers, Series Sixty Papers are light blue instead of yellow before they are exposed to light. They are handled the same as conventional papers—printed and washed with the same equipment and procedure. The advantages of Series Sixty Papers are described in detail in a new twelve page booklet, containing eighteen illustrations, diagrams, and charts.

I-R Two-Stage Compressors

Ingersoll-Rand Company announces a new two-stage compressor designed especially as an economical source of compressed air for garage and service stations.

The unit embodies the outstanding characteristics of the Type 30 line (to which it is the latest addition), including the V-shape design. This construction not only allows air circulation completely around each cylinder, thus assuring excellent cooling and high efficiency, but also provides excellent balance and smooth running. An outstanding feature is a simplified valve construction exclusive with this machine.



These compressors are manufactured in $1^1/_2$ and 2 horsepower sizes and are supplied with either horizontal or vertical tanks of 65 gallon capacity, or 80 gallon capacity in horizontal tank style only.

Lower power and maintenance cost is assured by these popular priced units which have many features usually found only in higher priced machines. Among these are a ball bearing compressor, an enclosed centrifugal unloader, separate cylinders, and a totally enclosed crankcase.

Detailed information is contained in bulletin 2436, copies of which are available from Ingersoll-Rand Co., 11 Broadway, New York, N. Y. or any of their branch offices.

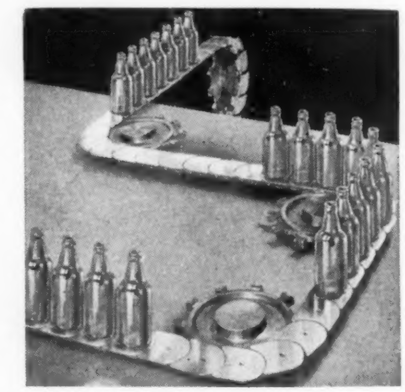
Two-Plane Link-Belt Conveyor Chain

Link-Belt Universal Carrier Chain is the name of a new chain announced by Link-Belt Co. as being capable of operating in two planes and particularly well suited for handling bottles, jars, cans in the process of manufacture, and in cleaning, filling and capping operations.

The high points of this chain are enumerated as: (1) that it permits sprocket engagement in two planes, and (2) that it is accurately made of finished steel to operate over cut-tooth sprocket wheels, resulting in exceptionally smooth conveyor movement.

The two-plane travel feature makes it practical to use this chain in rectangular, circular, semi-circular or irregular paths, and employ but one long conveyor, if desired, instead of several transfer conveyors with individual driving mechanism.

The construction of the chain provides for a continuous unbroken carrying surface of equal width, whether the chain is moving in a straight line or turning around a sprocket



wheel. It permits the use of a continuous chain in a conveyor system, using only one driving mechanism.

This new chain made its first official appearance as a part of the Link-Belt exhibit at the annual canning show held in the Stevens Hotel, Chicago, January 24 to 29, where it was shown in operation and attracted much attention. A 12-page illustrated book No. 1637, giving detailed information on this new chain and the sprocket wheels required, has been prepared, and will be sent to any reader upon request, which may be addressed to Link-Belt Company, 519 N. Holmes Ave., Indianapolis, or the nearest office of the company.

New Bar Stock Valves

Three new bar stock valves which have uses in almost every industry are being introduced by Crane Co., 836 S. Michigan Ave., Chicago, Ill. These small 3,000 pound W.O.G. plug type disc, globe and angle valves are called bar stock valves because their bodies and bonnets are made from solid bar stock. They are considered ideal for connections on orifice meters, regulator leads, by-passes, gauges, for use as expansion valves on ammonia lines and for many similar services where accurate regulation of flow is desired or where parts of measuring instruments must be protected against the sudden release of high pressures.

The Exelloy valves are particularly suitable for handling oil or gas containing sulphur compounds or for installations where steel valves do not have sufficient resistance to atmospheric corrosion.

The 18–8 alloy valves are especially suited for oil and gasoline containing hydrogen sulphide or sulphur dioxide when moisture is apt to be present. All of these valves may be packed when wide open when under

Continued on Page 18

Ljungstrom . . . the Air Preheater

that is built to give—

EASE OF INSPECTION of each part

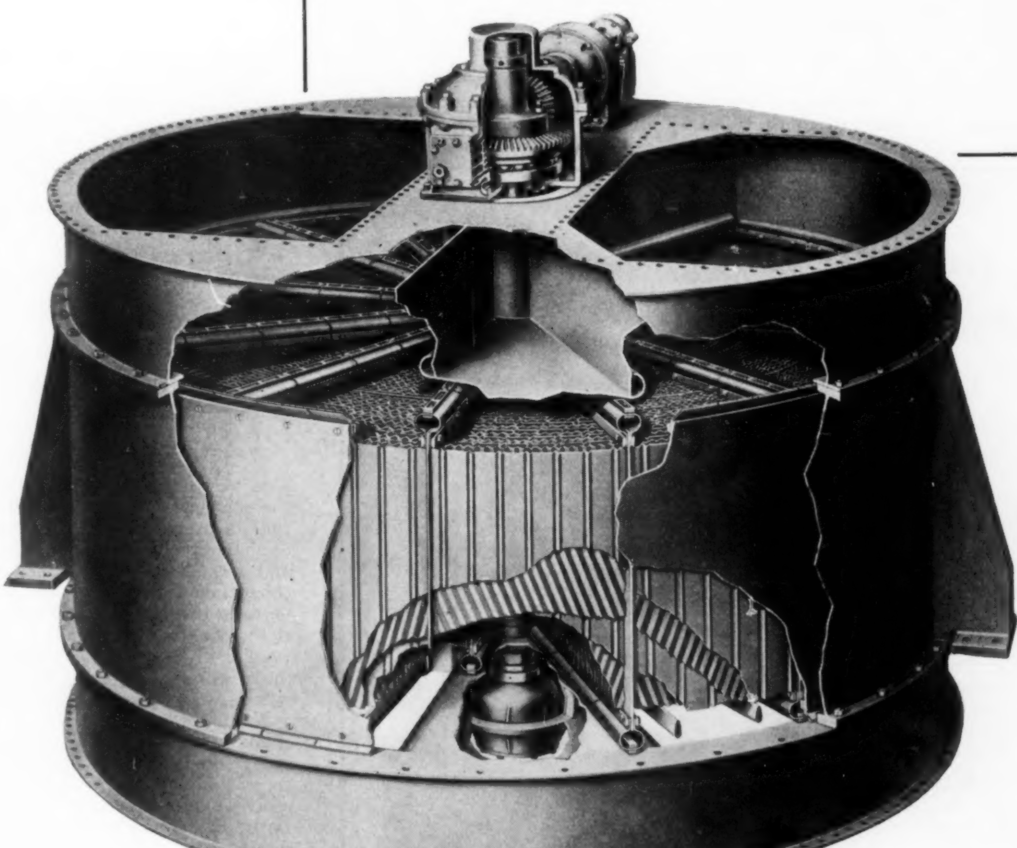
ACCESSIBILITY for cleaning and maintenance

AVAILABILITY for adjustment of heating surfaces to meet changing requirements

. . . with Minimum Weight and Space Requirements for Heat Recovered

* * *

These are some of the reasons why LJUNGSTROM Air Preheaters are Preferred



THE AIR PREHEATER CORPORATION

Under the Management of THE SUPERHEATER CO.

60 East 42nd Street New York, N. Y.

A 1168

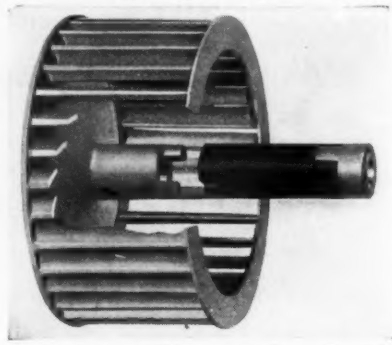
pressure. They are furnished either in steel, Exelloy or 18–8 chrome nickel alloy.

The new globe valve, No. $222^1/_2$, is made with male and female ends in sizes $^1/_8$ to $^3/_4$ inclusive. It is considered especially convenient where it is desirable to screw the valve directly into equipment having a female opening, thus eliminating the need for a nipple. Sizes $^1/_8$ inch and 1 inch also are being added to the existing Crane line or bar stock valves known as Nos. 222 and 223. Crane bar stock valves, therefore, now include the globe and angle patterns with female ends in sizes $^1/_8$ to 1 inch inclusive, and the new globe pattern with male and female ends mentioned.

New L-R Flexible Coupling

After an extended period in actual use, the Lovejoy Flexible Coupling Company, 5009 West Lake Street, Chicago, Ill., now announce to manufacturers of oil burners, refrigerators, washing and sewing machines, and other equipment where the load is not in excess of one-fourth horsepower, an application of the famous L-R Flexible Coupling principle that, it is claimed, delivers a superior type of service at a noteworthy reduction in first cost.

The L-R coupling principle is, briefly, to carry the power by means of metal jaws keyed to the driven and drive shafts, respectively, between which is interposed a resilient cushion of a type suited to the requirements of the operation. This makes lubrication unnecessary and, as there is no metal-to-metal contact, L-R couplings are always, and necessarily, longlived and noiseless. They also automatically absorb shock, overload, torque and other stresses. This new type Double-flex, 3 piece L-R Flexible Coupling styled UX, consists of two jaw units and a cushion unit made of a solid, tube-shaped section composed of hard rubber (about 90 Durometer), except where it contacts the jaws, where it is fashioned out of a softer, more resilient rubber (about 30 Durometer). This assembly produces a coupling that is strong and durable, adequately flexible, smoothrunning, and perfectly noiseless.



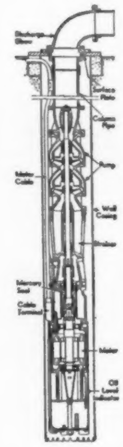
It is now possible to purchase from fan makers, fans with a hub built in the form of an L-R Flexible Coupling jaw (see illustration), for which there is no extra charge when the hub length is standard. If this is done, only two units have to be purchased to complete the coupling, viz., one UX hard rubber center piece, or cushion, and one jaw, resulting in a reduction in the cost of a complete coupling assembly of approximately one-third. Besides this economy, it is also claimed for this coupling that it makes possible the use of short shaft motors which are less expensive.

Repeats After Twenty-Five Years

Twenty-five years ago the Rochester Gas and Electric Co. of Rochester, N. Y., bought a 7500 kw turbine. The company selected Patrick Drumm, an employee with 21 years of service, to turn on the steam for the first time. It is doubtful if Mr. Drumm, who is now chief engineer of Station Three, expected to be on hand a quarter of a century later to do the same thing for the turbine that would replace the old one. But that is just what happened. Likewise, H. C. Ward, General Electric Co. salesman who sold the turbine to the R. G. & E. Co. in 1912, didn't realize that 25 years later he would be selling another G-E turbine to replace it. But that happened too.

The old turbine served a long and useful life. It could have been modernized and kept in service, but a thorough study showed that in the long run the new unit would be the better investment. Because of its more favorable water rate, the new turbine effects a considerable saving. The new machine is mounted on the same foundation which held the old one, electric welding making it easy to fabricate a sub-base which would accommodate the new installation.

Byron Jackson Submersible Pump



After eight years of successful performance under a wide range of operating conditions, the Submersible deepwell turbine pump has been placed on the market by Byron Jackson Co., of Los Angeles, Calif. This radical departure from the accustomed type of deep-well turbine pump has its motor below, and not above the turbine bowls. The propelling shaft is very short and the unusually long, small-diameter motor operates submerged at all times in the well water. However, the liquid pumped does not come in contact with the electrical parts or motor bearings, as these are enclosed in an oil-filled case with a mercury seal where the shaft passes through at the top. The turbine and the submersible motor form a compact unit that is attached to and supported by the discharge pipe. A submarine armored cable and a small copper oil tube, form the only connection (aside from the discharge pipe) between the pumping unit and the surface of the ground. The Submersible operates equally well and without frequent attention, in deep or shallow wells, crooked or straight wells, sumps or natural bodies of water.

Naturally, this new unit embodies many engineering features that are new to the turbine pump industry. The motor is a squirrel cage induction type and its rotor is carried on two ball bearings, one of which is a radial thrust to take both the small weight of the rotary parts, and the hydraulic load. The other ball bearing is of radial type, and its chief function is to center the rotor. A high dielectric oil is circulated through the entire windings at all times and, although the small copper tube affords a means for replenishing the oil supply, motors have operated continuously for several years without adding to or changing the oil supply.

Water is sealed out at the top by mercury in a rotating cup that is attached to the motor shaft. A cylindrical sleeve is placed around

Continued on Page 20

TUBE-TURNS are Accurate!

DIMENSIONAL accuracy in a pipe fitting isn't a mere theoretical advantage or "talking point"... It's an absolute, indispensable requirement for good welding—*and low costs.* (Ask your distributor for a copy of Tube-Turn Bulletin 107, and look on page 6.) ... *When you use Tube-Turns "of the same size as the pipe" they're really the same size.* That one fact is saving Tube-Turn users thousands of dollars every year... Tube-Turns, *Incorporated,* Louisville, Kentucky.

The word "Tube-Turn" is NOT a necessary general trade name for welding fittings. It is the registered trade-mark for the products made by Tube-Turns, Incorporated, under their patents.

• Keep Informed . . . *Continued from page 18*

the motor shaft, with one end attached to the motor casing and the other end submerged in the mercury. Thus the water and the water oil are sealed off on their respective sides. Since the first unit was put in service in February, 1929, there have been some 12,000 H.P. of Submersible units installed. The first pump, set 450 feet in a well and powered with a 50 H.P. motor, still delivers its rated 250 G.P.M. against a 475 foot head. Complete information is available.

Massachusetts Governor Inspects G-E Lynn River Works

It was "Governor's Day" at the Lynn River Works of the General Electric Co. recently when Charles F. Hurley, Governor of Massachusetts, inspected the plant. Above, he is being shown through the motor department by John Bucchiere, left, motor assembler, and Dean F. Smalley, right, general assistant to the manager of the motor department. In an address to over 2000 employees, Governor Hurley paid tribute to their loyalty and good workmanship.

Portable Pyrometer Test Kits

Portable Pyrometer test kits especially designed for use in vehicles and aircraft in motion are being offered the Industries by Lewis Engineering Co., Naugatuck, Conn.

One kit includes a portable Pyrometer Potentiometer, a Rotary Selector Switch, a coil of lead wire that can be cut to any desired length, and a system of specially designed thermocouples. The over-all guaranteed accuracy of this kit is $^1/_2$% of total scale deflection, when used with thermocouple material supplied by maker.

The portable Pyrometer Potentiometer requires only one balancing operation, and is unaffected by vibration. The scale is 8″ long, and can be supplied as a double range instrument having an effective scale length of 16″. The instrument has full cold junction and copper error compensation and its movable system has hardened and ground steel double pivots carried in sapphire bearings. The instrument contains no standard cell, and can be operated accurately in surrounding temperatures from −60° F. to +120° F. All compensations are automatic and require neither manual adjustment nor correction to the indicated readings. Most any scale range is available providing the span covers at least 200° F.

The Rotary Selector Switch enables the operator to take readings from a number of different thermocouples. It is a double pole switch, and has an "Off" position which permits the operator to check the zero adjustment without disconnecting the thermocouple wires. The switch is furnished in practically any number of positions besides the "Off" position, from 2 to 28. The size of the switches conform to 2″, 3″, and 4″, standard aircraft housing specifications.

The selection of thermocouples includes special designs for measuring air temperature, crankcase oil temperature, gear case temperature, radiator water temperature, cylinder head temperature, cylinder base temperature, liquid temperature under high pressure, fuel line temperatures, and many other applications.

A second kit consists of an indicating Pyrometer housed in a standard 3″ aircraft case having a round dial with a scale 2-$^1/_2$″ long. The movement is of a D'Arsonval galvanometer type, is very light and is mounted on hardened and ground steel double pivots carried in sapphire bearings. The permanent magnet is made of a special cobalt alloy steel. The instrument has a relatively high resistance and is provided with cold junction and copper error compensation. The instrument is calibrated for an external resistance of 3.5 ohms, which is a resistance equal to the sum of one 3 ohm interchangeable lead plus one .5 ohm interchangeable thermocouple. The overall guaranteed accuracy of this kit is 2% of total scale deflection when used with leads and thermocouples supplied by the maker.

Lead wires for use with the indicating pyrometer kit are made in lengths at 5′ intervals, from 5′ to 60′. All leads are interchangeable and all leads have a resistance of 3 ohms. The selection of thermocouples for use with either kit is made to have an external resistance of $^5/_{10}$ths of an ohm, so that all thermocouples are interchangeable with one another or with any lead.

• BUSINESS CHANGES

Morse Chain Appointments

Announcement has been made by Frank M. Hawley, manager of the Detroit plant of the Morse Chain Co., Subsidiary of Borg-Warner Corp., of two executive appointments.

Harold J. Skidmore, formerly assistant superintendent, has been appointed factory manager and superintendent, succeeding C. B. Mitchell, resigned. Mr. Skidmore has been with the Morse Chain Detroit plant over fifteen years. He was formerly with the Northway Motor Co.

L. D. Worden has been added as assistant sales manager, in charge of industrial products manufactured in Detroit plant, and will work under the direction of the Morse Chain Co's. general sales office, Ithaca, N. Y.

Mr. Worden was formerly associated with the W. A. Jones Foundry and Machine Co., as Detroit representative and has had wide experience in the engineering application of industrial products such as Morse builds.

Included among the products for which Morse enjoys a wide market, and on which Mr. Worden will apply, are Morse variable speed drives, industrial free-wheeling clutches and flexible couplings, which are now widely used in every industry, in conjunction with Morse silent chain and roller chain drives.

D. O. James Mfg. Co. Celebrates Fiftieth Anniversary

Mr. D. O. James incorporated the D. O. James Machine Company, in 1888, manufacturing Gears, Tools, Dies and Special Machinery employing approximately ten men.

In 1893 a new company was incorporated under the name James-Grant and Foote to manufacture Gears, Tools and Special Machinery employing about twenty men.

In 1895 D. O. James sold out to John Grant and several other interested parties and started James and Foote, a partnership.

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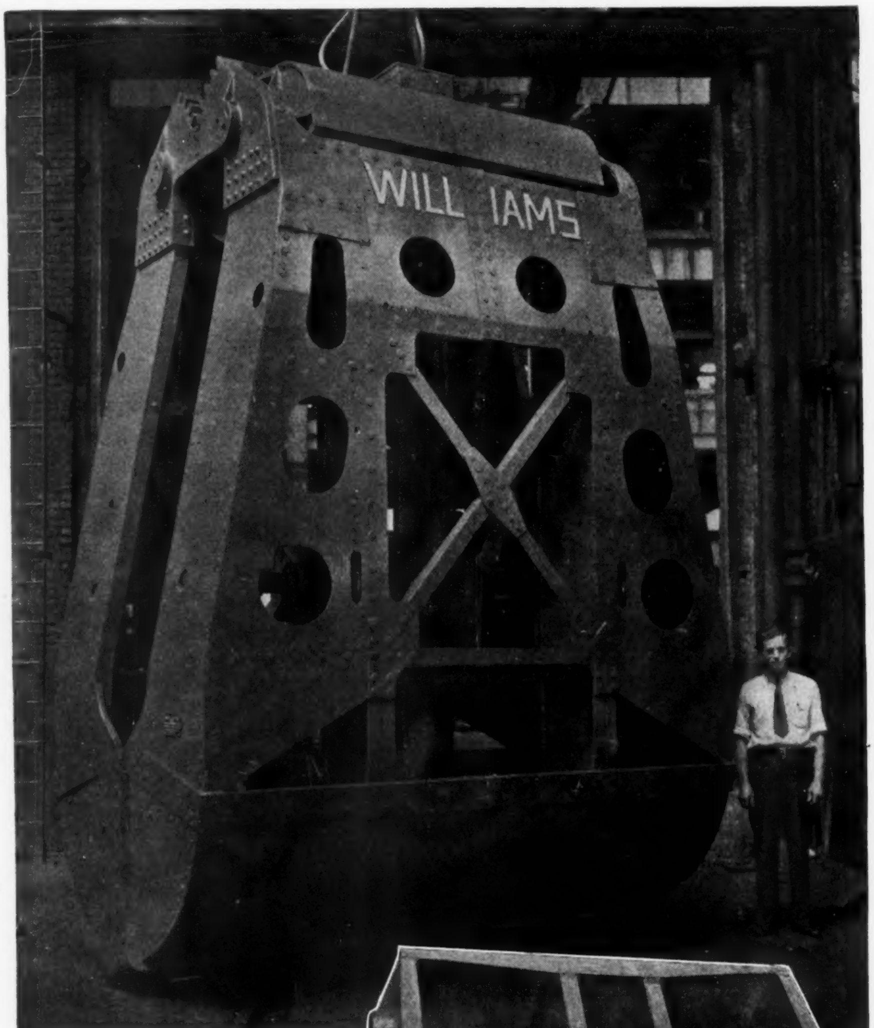
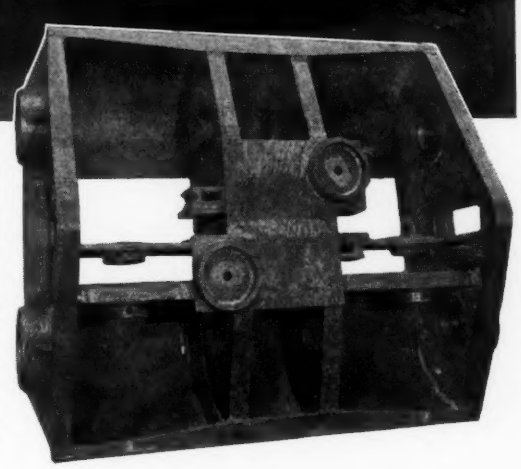
HOW TO BUILD EQUIPMENT THAT

Won't Break Down!





INSURANCE AGAINST BREAK-DOWNS. This clean-up coal bucket with scoops 9 ft. wide and 24 ft. spread is constructed of U·S·S MAN-TEN Rolled Steel throughout. All details, with the exception of the main frame which is unsuited for heat treatment, are welded construction. Dozens of rolled-steel-built buckets like this have proved their ability to stand up under the most severe service. Photographs—Courtesy of the Wellman Engineering Co., Cleveland, Ohio.

LIGHT — UNIFORMLY STRONG THROUGHOUT. Sheave Block for clean-up bucket using MAN-TEN with complete penetration welds (stress relief annealed). This design and the use of High Tensile Steel made substantial saving in weight possible.

Here's one way— *build it of the right kind of* ROLLED STEEL *— used in the right place*

"WRITE your own guarantee against breakage," say the builders of these material handling units. Their clam shell buckets, they claim, are built so strong, so resistant to tension, bending, fatigue and impact that " the customer, in effect, gets an insurance policy with every bucket."

What is their secret of success in building breakdown-proof machinery? Briefly this. These people are specialists in welded rolled steel construction. They know the heartless punishment their equipment must withstand. And, most important of all, they *know* from experience exactly *what kind* of rolled steel to use—and *where* to use it to get the best results.

They use U·S·S COR-TEN where they want to reduce dead weight and increase resistance to atmospheric and brine corrosion . . . U·S·S MAN-TEN to obtain increased strength at low weight . . . U·S·S Abrasion Resisting Steel where abrasive wear is severe . . . other special steels to meet other special needs. They freely combine one steel with another in the same design. Or they combine these steels with castings when such combination seems desirable.

Our experience in helping this fabricating company select rolled steels of the right analysis to simplify fabrication and insure the ultimate in service, is yours for the asking.

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

• Keep Informed . . .

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James and Foote manufactured Gears, Tools, Dies, Special Machinery and Milling Machines, also this new company made complete bicycles, bicycle parts, wringers, hangers, sprocket wheels and hubs, employing as high as 32 men. In 1905 their plant was destroyed by fire and the organization sustained a loss of some $30,000.00 and the partnership of James and Foote was then dissolved.

D. O. James then incorporated the D. O. James Mfg. Co., specializing in the manufacture of cut gears and Speed Reducing Transmissions designing and putting on the market the first Planetary Speed Reducer. Worm Gear Reducers were also made at this time.

From this time on the D. O. James Mfg. Co., made rapid strides due to the increased demand for Gears and Speed Reducers and at the present date is the largest manufacturer of all types of Gears and Speed Reducers in this country, and now the D. O. James Mfg. Co., located at 1120 W. Monroe St., Chicago, manufacture a complete line of power savings products as follows: Planetary Spur Gear, Medium and Heavy Duty Worm Gear, Generated Continuous-Tooth Herringbone Gear and Motorized Speed Reducers in types to drive up, down, horizontally or at an angle, Cut Spur, Straight and Spiral Bevel, Mitre, Spiral, Worm, Internal, Helical and Herringbone Gears in all sizes and of all materials, Sprocket Wheels, Racks, Flexible and Universal Couplings.

• LATEST CATALOGS

High Speed Ship Propulsion Turbines

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has just issued a new bulletin 1189 covering high speed modern ship propulsion turbines in considerable detail. It is well illustrated with line drawings and photographs to show all construction features of these units. The make-up and completeness of the bulletin is more along the lines of construction manual than a conventional sales bulletin.

Bailey Boiler Meters

A 32-page bulletin, "Bailey Boiler Meters" containing an analysis of 7,000 combustion tests made during the last twelve years on all types and sizes of boilers including a full range of fuels and methods of firing, has just been published by Bailey Meter Company, 1026 Ivanhoe Road, Cleveland, Ohio. In addition to describing the Bailey Boiler Meter and the ways by which it reduces boiler operating cost, this bulletin shows graphically the average percentage of excess air with which various classifications of boiler units are operating in actual practice. It also shows the percentage occurrence of limiting factors in reducing excess air for combustion under boilers with various types of firing and furnace wall construction. These factors are named as: (1) Furnace Maintenance, (2) CO, (3) Smoke, (4) Ash Pit Loss or combustible in flue gases. It is a bulletin which should be in the reference file of every Combustion Engineer concerned with steam power plant problems.

Nickel in the Brass Foundries

In order to promote the production of sound and dense castings in 70:30 copper-nickel and thereby improve the quality of pumps, valves, steam fittings or other equipment cast from this alloy, a paper presented originally before the last annual convention of the American Foundrymen's Association has been republished in a series of bulletins on "Nickel in the Brass Foundry" by The International Nickel Co., 67 Wall St., New York, N. Y.

Although the foundry practice described in this paper is based upon the casting properties of 30% cupro-nickel, adequate gating, and closely controlled composition and pouring temperature are sound principles for other highly alloyed casting compositions.

Brown Flow Meters

The Brown Instrument Co., 4496 Wayne Ave., Philadelphia, Pa., has just published 2 new folder—"Jim is Right."

This folder explains how Brown Flow Meters, by metering Steam, Water, Oil and other fluids, can bring to manufacturing processes many of the economies they have effected in power production. It includes several illustrations demonstrating the savings that have been made in the generation and distribution of steam.

A-C Small Electric Hoists

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has come out with a new bulletin on Small Electric Hoists covering units suitable for rope pull up to around 8000 pounds designed for mine service and in general built along the lines of that Company's larger units. It covers both single and double drum types which can be equipped with modern safety devices and built for alternating or direct current drives.

Heat Treatment of Steel

Vapocarb-Hump . . . the triple-control method for heat-treatment of steel, is described in a new 36-page catalog just issued by Leeds and Northrup Co. According to the manufacturer, a special effort has been made in this publication to show, more clearly, than in any previously issued, the high-quality of output and far-reaching savings which complete control of tool surface, shape and structure is giving to hundreds of Vapocarb-Hump users. The Catalog is especially well illustrated, not only with views of representative installations, but with diagrams, chart records and pictures of many types of tools and dies hardened by the Method. Copies may be obtained by addressing Leeds and Northrup Company, 4963 Stenton Avenue, Philadelphia, Pennsylvania. Ask for Catalog T-621.

Garlock Split-Klozure Oil Seal

The Garlock Packing Co., Palmyra, N. Y., announces a new booklet just off press featuring their "Garlock Split-Klozure Oil Seal." This is a patented oil seal which is split, or cut open. It is applied by placing it around a shaft in somewhat the same manner as an ordinary packing ring is applied, instead of sliding it over the end of the shaft as is necessary with solid oil seals of the conventional type.

DeLaval Centrifugal Pumps

That centrifugal pumps, like other kinds of machinery, are continually being refined in design and improved in construction is apparent from a booklet published by the De Laval Steam Turbine Co., Trenton, N. J. Photographs and sectional views show the special features of single stage and multi-stage pumps for small and large capacities and for all heads, including high duty pumps for general service, mixed flow pumps and propeller pumps for large capacities at low heads, clogless pumps for sewage and paper

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• Keep Informed . . .

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stock, and boiler feed pumps for the highest modern steam pressures. A rotary displacement pump for lubricating and fuel oil is also shown.

New G-E Instrument Brochure

"When You Can Measure," a 32-page brochure recently published by the General Electric Co., Schenectady, N. Y., tells in brief the contributions of General Electric engineers and scientists to the important art of measurement. This beautifully printed publication describes in pictures and in words the story of how instruments are designed, constructed and tested in the "headquarters for electrical measurement."

Every development in electricity has grown out of experiments in which instruments played a major part. The incandescent lamp, the electric motor, electric household appliances, radio—none of these commonplaces of modern living would have been possible without the imposing array of ingenious, sensitive, accurate measuring devices engineers have perfected. Since measurement, in its final form, depends upon comparison with some carefully chosen standard, a section of the booklet is given over to a description of the Company's standards of voltage, resistance, time, and temperature.

Brown Pneumatic Remote Transmission

The Brown Instrument Co., 4496 Wayne Ave., Philadelphia, has just published a new folder on The Brown Pneumatic Remote Transmission System.

This system was developed by The Brown Instrument Co., for remote transmission of measurement and control in hazardous atmospheres—where the use of electrical transmission is not permissible. The system's Principle of Operation and the simple, rugged construction of the Transmitting Unit are illustrated by schematic diagrams.

Belt Conveyor Idlers

The C. O. Bartlett & Snow Co., 6450 Harvard Ave., Cleveland, Ohio, manufacturers of bulk material conveying and elevating equipment, announces the completion of a new Belt Conveyor Idler Bulletin—No. 80. The new bulletin contains 24 pages. It is fully illustrated, and contains complete details of a new line of Timken bearing equipped Belt Idlers—said to be the first—and thus far the only idlers so constructed that the exact adjustment of the bearings can be made at the factory and the rolls mounted in the brackets in the field without altering or changing this adjustment in any way. Copies of the new bulletin, which gives prices, weights, etc., are available.

Temperature Instruments for the Steam Plant

A new 32-page illustrated catalog on "Micromax Temperature Instruments For The Steam Plant" is offered to executives, engineers and operating men concerned with steam generation . . . whether in central stations or industrial plants. It shows how temperature measurements help to effect important operating economies. It describes three methods of measurement: (1) the thermocouple pyrometer, used for most steam-plant temperatures; (2) the resistance thermometer, recommended for low temperatures; (3) the optical pyrometer which measures temperatures within the furnace. Lastly, it presents Micromax indicators, recorders, controllers and accessories usually chosen for steam-plant use. To receive a copy, ask Leeds & Northrup Company, 4963 Stenton Avenue, Philadelphia, Pennsylvania, for Catalog N-33-163.

A-C Turbo Blowers

Allis-Chalmers Mfg. Co., Milwaukee, Wis., has released a new bulletin 1911 describing single stage turbo-blowers of the overhung type, pedestal type and double inlet type, built for capacities from 600 cmf to 10,000 cmf, for air pressures from 1#G to 6#G. They are driven by electric motors or steam turbines, sometimes through speed reducing gears. These machines are applicable to:—Scavening Diesel Engines, Exhausting Gas, Blowing Foundry Cupolas, Aerating Sewage, Boosting Gas, Circulating Gas in Chemical Plants, Copper Flotation, Glass Blowing and Mould Cooling, Oil Burning, and Agitating Yeast. This bulletin is profusely illustrated and contains information of interest to the student as well as to the buyer and can be obtained from the Blower and Compressor Division, Milwaukee, Wis.

COMING MEETINGS AND EXPOSITIONS

For the next three months

MAY

9–10	American Management Association, 9th Annual Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.
9–11	American Institute of Chemical Engineers, Semi-Annual Meeting, Greenbrier Hotel, White Sulphur Springs, West Virginia.
14	Eastern Photoelasticity Conference, 7th Semi-Annual Meeting, Harvard University, Cambridge, Mass.
14–21	Tenth International Petroleum Exposition, Tulsa, Oklahoma.
Wk. of 14	American Foundrymen's Association, Annual Convention and Exhibit, Cleveland, Ohio.
17	Society of Naval Architects and Marine Engineers, Spring Meeting, Washington, D. C.
23–25	American Petroleum Institute, Mid-Year Meeting, Wichita, Kansas.
26	American Iron & Steel Institute, General Meeting, Waldorf-Astoria Hotel, New York, N. Y.

June

12–17	Society of Automotive Engineers, Summer Meeting, The Greenbrier, White Sulphur Springs, W. Va.
19	National Aeronautical Association, 2nd Annual Santa Ana, Calif., Air Show.
20–24	American Institute of Electrical Engineers, Annual Summer Convention, Washington, D. C.
20–22	American Society of Heating & Ventilating Engineers, Semi-Annual Meeting, The Homestead, Hot Springs, Va.
20–24	American Society of Refrigerating Engineers, Spring Meeting, State College, Pa.
Wk. of 20	American Society of Mechanical Engineers, Semi-Annual Meeting, St. Louis, Mo.
27–30	Society for the Promotion of Engineering Education, Annual Meeting, A. & M. College of Texas, College Station, Texas.
27–July 1	American Association for the Advancement of Science, Summer Meeting, Ottawa, Canada.
27–July 1	American Society for Testing Materials, Annual Meeting, Atlantic City, N. J.
29–30	Institute of the Aeronautical Sciences, Inc., Technical Meeting, Ottawa, Canada.

JULY

6–9	National Aeronautical Association, 11th National Championship Model Airplane Contest, Detroit, Michigan.

The *Standards* COLUMN

News of Interest to Manufacturers

Involute Splines

EVERYONE who drives an automobile relies on the proper functioning of at least two splines whenever he shifts the transmission gears. Originally, and even at present, square or straight-sided splines were largely employed in automotive, machine tool, and other applications. Recently, however, there has been a definite trend in industry toward the use of involute splines.

As a consequence, Technical Committee No. 13, C. W. Spicer, chairman, of the Sectional Committee on the Standardization of Small Tools and Machine Tool Elements (B5) has taken up, first, the development of a proposed American Standard for involute splines. This work was begun in 1936 and in December of that year a tentative draft was discussed at a meeting of Technical Committee No. 13 and was very favorably received.

This proposed standard is intended to serve as a basis for the design of interchangeable splined shafts and fittings. It is recognized that more or less deviation from this standard practice will be necessary to meet the conditions imposed by engineering or production requirements. Variable factors, such as length of spline, type of material, heat treatment, and limitations of production equipment, will necessitate the exercise of intelligent engineering supervision in adapting this proposed standard specification to a particular application.

To minimize the requirements for specials the proposed standard provides an option of three depths in each of five series covering 6, 10, 16, 24, and 36 tooth splines. The selection of the 6, 10, 16, and 24 tooth numbers was dictated by their present use on square splines and the preference accorded them in the early development of involute splines. On the 6, 10, and 16 splines, the SAE square or straight-sided spline depths for deep, intermediate, and shallow splines have been incorporated in the proposed involute standard. On the 24 and 36 splines these depths are decreased by the inherent character of involute geometry.

Inasmuch as the dimensions of anti-friction bearings usually control or limit spline design, the metric bores universally used in anti-friction bearing practice formed the basis for the size ranges covered by the proposed standard, and the spline sizes have been designated by the symbols used in bearing practice. The range in the proposed standard from No. 04 (20 mm) to No. 22 (110 mm) is approximately equivalent to a fractional size range of $^3/_4$ to $4^3/_8$ inches.

The letter ballot vote of the members of the sectional committee on this proposal is in progress and when completed the standard will be placed before the three sponsor societies for approval and transmission to the American Standards Association.

For further information—address

The American Society of Mechanical Engineers
29 West 39th St., New York, N. Y.